TRAFFIC QUARTERLY

AN INDEPENDENT JOURNAL FOR BETTER TRAFFIC

JULY 1961

Licensing Drivers

Two New Parking Systems

Transportation Planning Models

Old Colony Transportation Problem

Lincoln Road Mall in Miami Beach

Transportation in the United States

The Ideal Highway Department

Swiss General Traffic Plan

Serving Motorists in Ohio

Intersections at Night

THE ENO FOUNDATION FOR HIGHWAY TRAFFIC CONTROL

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Eno Foundation publications are provided from an endowment by the late William P. Eno.

Volume XV, Number 3 July, 1961

PRINTED BY COLUMBIA UNIVERSITY PRESS, NEW YORK, N.Y.

Traffic Quarterly

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Published quarterly by the Eno Foundation for Highway Traffic Control, Inc., at Saugatuck, Connecticut, issue for July 1961. Printed in the U.S.A. Library of Congress catalog card: 50–1781.

Permission to reprint articles from this magazine may be obtained without charge on request to the publishers, Eno Foundation, Saugatuck, Connecticut.

Driver Qualification

It is perplexing to the observant driver that when he meets another car, one or the other, sometimes both, necessarily maneuvers to a safer passing interval. Whether this is psychological or real, it is indicative of faulty driving and contributes to accidents.

How well you drive is of limited importance if you cannot rely on your fellow driver to do likewise. This is the weak link in our efforts to promote reasonable and sensible driving on our highways.

In our driver-qualification systems, many applicants receive licenses who are, willfully or otherwise, incompetent to abide by official road regulations, courtesy or the inherent safety of other drivers.

Though each year we add more drivers to the list of officially qualified drivers, this is small reason for the continued high rate of accidents. Some might reason otherwise, on the basis that the more cars on the road the more accidents are to be expected.

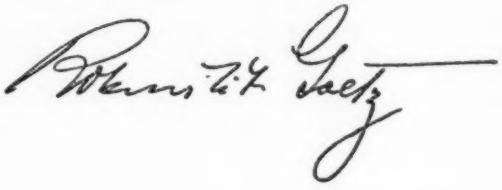
Others might contend that our driving should improve for the substantial reason that cars, roads, signing and lighting have improved. We have also improved some qualifying procedures in our licensing measures and provided for withdrawal of licenses for sufficient cause. This should be an effective combination when rigidly and fairly enforced, with full consideration for the innocent victim of the offender's reckless and unlawful driving.

Much depends on the licensing authority, the examiner, policing and the courts. In our endeavor to improve the national character of our driving, we are providing the utmost in cars and highways. In this respect we are exceptional.

It is questionable whether our present driver-qualification methods really determine the ability to drive well or on high-speed highways. Many are mentally incompetent to make a prompt response to another action—many drive beyond their competence.

Undoubtedly many accidents occur from cutting in and out because of unwarranted slow driving. In our efforts to improve our driving and lower our accident rates, we should long ago have adopted minimum as well as maximum limits.

Our highways should provide competent drivers with all the accommodations that a motoring public requires, and for the maximum traffic with due consideration for safety.



Transportation Planning Models

MELVIN M. WEBBER

Melvin M. Webber, Associate Professor of City Planning at the University of California, Berkeley, was formerly Senior Metropolitan Planner with Parsons, Brinckerhoff, Hall and Macdonald on the San Francisco Bay Area Rapid Transit Study. He is Editor of the Journal of the American Institute of Planners.

URBAN transportation planning and city planning are undergoing a major change. The newly discovered applicability of some long-standing social science theory, combined with some important findings coming from recent transportation and planning studies, is inducing a new way of thinking about metropolitan areas and about transportation systems.

With the increasing understanding that the new studies are bringing, we are beginning to learn how we may dovetail our plans for the various subsystems of the metropolis to comprise internally consistent plans for the larger metropolitan system.

The prospects for developing scientific bases from which to formulate policies for metropolitan growth were never brighter. But the early applications of this new knowledge suggest that we may be using it to solve problems in ways that may breed new problems more severe than those the initial solutions attempted to relieve.

APPROACHES TO LAND USE FORECASTING

The outstanding feature of the change that has already taken place in transportation planning is the widespread acceptance of the proposition that transportation facilities and traffic are intimately related to land use. There has now been so much empirical demonstration of the association of land use and traffic that it is difficult for the traffic engineer any longer to avoid involvement with land use studies. The relationships between transportation facilities and land use patterns are less-well understood, however.

At this stage in our development, we have already gained considerable proficiency in simulating the interzonal traffic movements

that are implicit in an existing land use pattern. Traffic estimating, based on land use, is becoming a stock procedure within the traffic engineering profession. But because the traffic forecasts based upon land use forecasts are of such recent origins they have not yet been adequately tested against field traffic counts. Little of the future has as yet arrived. Even when the future does become the present, the tests may still be inconclusive, since the projected land use patterns may not materialize. If the future land use patterns do not develop as forecasted, neither will the traffic. Since traffic forecasts have come to rely so heavily upon land use forecasts, it is important to be able to predict land use with high levels of confidence. How can this be done? And then, if our forecasting skills can be improved, how can we gain greater confidence that the forecasted land use patterns are also desirable patterns?

THE STATIC-DESCRIPTIVE LAND USE MODELS

The empirical studies of land use forms that have been cumulating in the social sciences since the 'twenties are being confirmed by the more recent work conducted in metropolitan-transportation and metropolitan-planning studies. They reveal some remarkably consistent regularities among the land use patterns of American metropolitan areas and in the land use patterns of single metropolitan areas over time.

The patterns have been described statistically and mathematically, and these formulations have become the bases for much of the land use forecasting that is now associated with transportation planning.

Expansion factors are applied to account for total metropolitan population and economic growth; land use is then projected; trip-ends are generated from the forecasted land use; zonal interchange is tested against a hypothetical transportation network; the network is then revised to match the interzonal demands; and the transportation facilities are then designed and constructed.

Most of the land use models that are being applied are merely descriptive, and they are both static and positivistic. For example, they describe the rate at which resident-population density declines from the peak density at or near the metropolitan center. Similarly, they describe the rate of decline in manufacturing or business em-

ployment and the composition of the mix of land use categories at various distances from the center.

These models have nothing to say about the *processes* of change or about the *causes* of change. Being descriptive of the empirically observed spatial patterns in which land use categories are found, they deal with land use as a stationary rather than as a process phenomenon, and they view land use pattern as a static rather than as a changing configuration. In addition, these models say nothing about the possibilities for willful redesign of land use patterns; it is assumed that land use patterns are positively determined by forces lying outside human control.

NATURAL LAWS OF URBAN FORM

The consistency with which the static-descriptive equations do indeed portray existing and past land use patterns has encouraged a high level of confidence in the formulations. It is thought that, since the spatial forms they describe have held so firmly in the past, they probably represent the expression of some natural laws of urban form, not unlike the natural laws controlling the configuration of iron filings in a magnetic field or the natural laws controlling the performance of steel beams. Indeed, it is the laws of Newtonian physics that furnished the initial analogs for the static-descriptive land use and traffic models and that lent them that larger conceptual framework.

The beauty of the generalizing conception that simplifies and gives order to previously unorganized observations certainly makes the generalization attractive. Problems that once seemed insurmountable now become manageable, if not routine. And so it now appears with land use forecasting.

If natural law *is* at work here, we can trust that future land use patterns *will* exhibit the regularities that we can empirically observe in the present and in the past. And if the laws are direct analogs of the laws of statics, who is better equipped to forecast these patterns than the men who receive the most rigorous professional training in the applications of the laws of statics?

But the case for such a naturalistic view of metropolitan form has not been made by the empirical investigations that support it. However accurately the descriptive models may depict existing land

use patterns, there is no assurance that they will also describe land use patterns in the future. The kind of positivistic, empirical derivation that has validity for examining the strength of materials needs not also be valid when applied to the behavior of humans.

This is because the factors that affect the tensile strength of steel are probably not about to change very much over the course of a few centuries or a few thousand years; but the factors that affect the locational choices of families and business firms are currently in rapid flux. Within a few decades patterns of human behavior and the resulting land use patterns may be quite different from those we currently know.

DYNAMIC-BEHAVIORAL APPROACH TO LAND USE DETERMINATION

If there is a consistency underlying land use patterns, it is probably not a consistency in pattern per se. Rather, the consistency is in the economic and social behavior of the individuals who locate their houses and their business places. None of these individuals is seeking to shape the metropolitan-wide land use pattern, of course; nor is he seeking to increase his neighbor's welfare. His motivations are private; he is seeking a location that, according to his private calculus, will serve to increase his own welfare.

The search for the appropriate location for his house or his business represents a search for a combination of environmental qualities that might best suit his peculiar preferences or needs. These qualities include, among others, accessibility to the other urban establishments with which he deals, such as an employee's work-place or a manufacturer's suppliers; availability of certain on-site services, such as water and sewerage; the presence or the promise of certain varieties of amenity, including those associated with climate, landscape, visual scene, and social status; and the availability of adequate space of the appropriate quality, size, and shape.

Of course, his capacity to compete for the location that represents the optimum combination of these various qualities is limited by his income and is conditioned by his preference for other things that his money might buy. Others may be willing and able to spend more for that optimum site, and he would then be forced to accept a different one, having fewer of the qualities he regards as his personal optimum.

In the intricately competitive web within which each of several

million households and several thousand firms seeks to approximate its own optimum, a consistency does indeed emerge. But it is not necessarily a consistency in land use form.

If a roughly similar mixture of people and firms, having roughly similar characteristics, compete for locations in two different cities where the environmental qualities are also roughly similar, we may expect that the resulting land use pattern will also be roughly similar.

Over the course of the past fifty years in the United States all of these conditions have been met. Most large metropolitan communities have been roughly similar in their population and economic compositions, and they have all developed within a roughly similar institutional framework and with essentially the same technology.

The similarity in their land use patterns has reflected these cultural similarities. Where dissimilarities have existed, the land use patterns have also reflected them. And when we compare the typical large North-American metropolis with the typical large Latin-American metropolis where institutional and technological differences have been relatively large, the dissimilarities in the resulting land use patterns are apparent.

For example, in North America, lower-income families live in high-density housing in the metropolitan center, while upper-income families occupy low-density housing on the fringe. In South America, exactly the reverse holds: low-density shack-towns encircle the metropolis, and high-density luxury apartments crowd the center. If natural law controls density gradients of income groups, it seems at least to be subject to considerable cultural extenuation.

If the observations we have made so far are valid, and there is no natural law of urban form but only a consistency in the economizing behavior of culturally conditioned, individual location-seekers, then it follows that the static-descriptive models that derive from recent land use measurements may not adequately describe future land use patterns.

They would not, of course, if any of the crucial conditioners of locational choice were to change in the future—if people's scales of preferences among environmental qualities were to change markedly or if the external conditions that shape those qualities were to change. And the most likely prospect is that they *will* change.

Apart from those large imminent changes in people's preferences

that will accompany the trends toward higher income levels, increased leisure time, and greater social and geographic mobility, there are a number of other changes already under way that could have a great impact on urban land use patterns. Some of the most dramatic of these developments are occurring directly in the field of transportation; some are the direct consequences of transportation planning itself.

SPEED-INCREASES AND TRIP-MILEAGE

We are rapidly moving to a condition in which differentials in travel time between any two points of the surface of the earth will approach zero. Some of the technological improvements in transportation equipment that will permit this are already with us; others are now actively being developed. It appears that we will soon have the technological capability of building an array of specialized transportation facilities that will permit speed of travel to increase directly with mileage-length of trip.

This development has been under way for many years, of course; and travel-times between any two metropolitan centers in the United States are already approaching equality. Innovations in high-speed intrametropolitan transportation systems have been slower to develop, although urban freeway and rapid-transit facilities are precisely of this sort. When the very-high-speed intrametropolitan transportation systems that are now under study are built as supplements to our present systems, the reduction in travel-time differentials here are likely to be as dramatic as those that have accompanied improvements in intermetropolitan air travel.

Despite the high dollar-costs that attach to high speeds, the affluent Americans seem to be increasingly willing and able to pay those costs. We seem to be more concerned with the way we spend our limited supply of hours for travel than we are with the way in which we spend our limited supply of dollars. This frugality with time has shown up repeatedly in traffic studies. It appears that households and firms seek to locate in those places that permit them to economize on travel time, even though the out-of-pocket costs of travel or of message-sending may be relatively high there.

This being so, higher travel speeds will have the effect of greatly increasing locational freedom. To narrow differentials in intra-

metropolitan time-distances is equivalent to reducing the importance of mileage distance in the individual's economizing calculus.[1] In turn, the effect is to make other environmental qualities relatively more important than they previously were and to create the possibilities for geographic patterns of land use quite different from those we have known.

Of course it is not necessary to await the advent of 200-mph metropolitan transportation systems to observe that transportation facilities have a major impact upon land use patterns that develop after them. Every new transportation facility, of whatever sort, introduces a modification in the time-distance relationships among different locations. Some combinations of locations enjoy a relatively greater reduction in time distance than others, and the transportation system is in that sense discriminatory.

Firms and households in the favored locations will prosper more than those in the less favored locations. Some will sell out to new establishments that are now willing to bid higher for the favored sites, thus triggering a chain of moves that will reverberate throughout the metropolitan land market. Depending upon the spatial configuration of the transportation system—and apart from simultaneous changes in other environmental qualities or in preferences—the responses in the land market and in the metropolitan economy may tend to encourage investments in the metropolitan central business district, or to encourage investments in subcenters instead, or both, or neither.

It has become commonplace during the past few years for transportation engineers to expect that a freeway interchange will induce the development of an adjacent shopping center, residential subdivision, or industrial district. It is generally understood that a rapid transit station will generate neighboring investments in offices, apartment houses, and retail shops.

But it seems not to be as generally understood that the repercussions of any relatively major change in the transportation system

1. Recent studies in Hartford, Connecticut, and in Baltimore-Washington indicate that this is largely true already. Within the range of travel-times that the studies were concerned with, accessibility appears to be less closely correlated with new urban development than do availability of adequate space, sewerage, and the less tangible amenities. See Alan M. Voorhees, "Development Patterns in American Cities," Paper presented at the Annual Meeting of the Highway Research Board, January 1961. (Mimeo.)

will be felt in all parts of the metropolitan area over the long-range future. Not only does a change in time in time-distance relationships influence the immediate locational responses of the affected establishments in the short run; subsequent locational decisions of other establishments will be influenced, in turn, by the then-existing land use pattern they must accommodate to.[2]

So sensitive are we to differences in time-accessibility to others with whom we have dealings, hence so responsive are we to changes in the transportation system, that the entire metropolitan land use configuration is a direct function of our transportation system's design.[3]

THE UNAVOIDABLE VALUE QUESTIONS

Yet, transportation planning is still dominated by the idea that transportation facilities are to be designed to serve existing and projected demand for traffic service. Now that we know that the best clues to information about traffic demand lie imbedded in information about land use, transportation engineers are seeking a workable way of getting good information about land use, and especially about future land use.

Distrustful of the city planner's judgmental and valuative approaches to land use planning, the engineer has been quick to adopt the positivistic land use models as a means for substituting land use forecasting in the place of land use planning. The attractiveness of these models lies in their promise of a relatively simple and straightforward method of portraying future land use patterns with the precision and the certainty that good engineering demands.

2. In a brilliantly conceived paper, in which they present a behavioral, dynamic, and normative conception of metropolitan transportation planning, Wingo and Perloff have clarified this distinction between the short- and long-run effects. See Lowden Wingo, Jr. and Harvey S. Perloff, "The Washington Transportation Plan: Technics or Politics?", *Papers and Proceedings of the Regional Science Association*, Vol. 7 (1961), forthcoming.

3. The findings of the Hartford and the Baltimore-Washington studies (*op. cit.*) do not negate this proposition. The designs of the transportation systems there appear to have reduced time-distance differentials among the various newly urbanizing sectors to within so narrow a range that locators are indifferent to the small differences that remain. Had the transportation systems created large inequalities in travel time, accessibility might have shown up as being more directly associated with new development in the correlation analyses. The same conditions may pertain in Los Angeles where an early grid of boulevards nearly equalized travel-times for all equally distant segments of the metropolitan area. In each of these areas, it is important to observe that new growth is occurring at the fringes of existing development, not 100 miles away. Space and natural amenities are plentiful in the country, but time-accessibility is not.

Equally important, these models hold out the promise of eliminating the bothersome value questions. If land use patterns are determined by natural forces that are outside the control of men, then deliberation about the relative desirability of different city forms—about the relative merits and demerits of high-density subcenters, or many of the other concerns of city planners—become idle speculation.

Given a positivistic "science" of land use, the task of projecting the future can be mechanistically dealt with simply by forecasting. Although forecasting of most social characteristics is inherently an extremely difficult undertaking, because of the many uncertainties and the many unknowables that the future holds, if we believe that the future will be like the present, forecasting requires only that we carefully observe the current scene.

If, however, land use patterns are determined by culturally conditioned and changeable patterns of human behavior rather than by stable natural law, and if the land use patterns that the positivistic-descriptive models predict therefore turn out not to be the patterns of the future, then there may be no escaping the more difficult task of normative, land use planning.[4]

More than that. If the effects of transportation facilities are to shape the locational decisions that households and firms make, there is no escaping the need to assess the value preferences that individual locators hold. And since the sum of individual locational decisions cumulates to create the over-all metropolitan land use pattern, there can be no escaping responsibility for deciding in advance of transportation construction what pattern of land use is most to be desired —not only by the individual locators but, even more important, by the aggregate metropolitan community.[5]

4. For a most insightful discussion of the role of forecasting in planning, see Britton Harris, "Plan or Projection: An Examination of the Use of Models in Planning," *Journal of the American Institute of Planners*, Vol. 27, No. 4 (November 1960), pp. 265–272.

5. The Penn-Jersey Transportation Study, now in process, is unquestionably the most emphatic and most sophisticated effort to meet this responsibility that has yet been made. The Study is seeking to develop and apply dynamic-behavioral-normative models in developing its transportation plan. Much that is suggested in this paper has been influenced by the work being done there. See the Study's *Prospectus* (1959); Henry Fagin, "Comprehensive Urban Planning," an address given at the conference on Transportation of the National Academy of Sciences-National Research Council, Woods Hole, Massachusetts, August 1960 (mimeo.); Britton Harris, "Some Problems in the Theory of Intra-urban Location," (mimeo.); and John D. Herbert and Benjamin H. Stevens, "A Model for the Distribution of Residential Activity in Urban Areas," *Journal of Regional Science*, Vol. 2, No. 2 (Fall 1960), pp. 21–36.

The value neutrality of transportation planning is clearly impossible. A transportation system does not solely serve traffic demand. Its major effect is to modify and shape time-distance relationships, hence to modify locational decisions, hence to modify over-all land use patterns, hence to modify spatial linkage patterns, hence to modify traffic movement patterns. The effect of a transportation system, then, is to create its own traffic demand.[6] The only way out of this causal circle is to impose, from the outside, a policy decision—i.e., a political decision—at least about the desired patterns of land use and traffic movement.

NEED FOR NORMATIVE APPROACH TO METROPOLITAN SYSTEMS PLANNING

Two facts conspire against a positivistic, traffic-service approach to metropolitan transportation planning. The first, which we have already mentioned, is the powerful role that transportation facilities play in the matrix of causal chains by which the economic, social, political, and governmental structures of the metropolitan community are shaped. The second is the powerful role that centralized government plays in constructing these transportation facilities.

It is helpful to view the metropolis as a complex system within which many interdependent and interacting individuals and groups perform specialized services of various kinds.[7] The ways in which these groups are organized, the ways in which they relate to each other, the mutually accepted rules by which their behavior is governed, and the processes and causes of change are, of course, central concerns of the social sciences and of those professions that seek to influence them.

It is in the nature of things that, to conduct their activities, groups should be located in space on the surface of the land. The conduct of these activities in turn requires certain physical facilities to house them and certain other physical facilities to link groups that

6. See also, Melvin M. Webber, "The Transportation Engineer's Role in Community Development," *Proceedings*, Thirteenth Annual Western Section Meeting, Institute of Traffic Engineers (1960), pp. 4–8.

7. The application of systems analysis to metropolitan communities is being actively explored in many quarters. For an outstanding discussion, see *Conference on Transportation Research*, Report of a Study Group Convened by the National Academy of Sciences, at Woods Hole, Massachusetts, August 1960; Publication 840 of the National Academy of Sciences-National Research Council, Washington, D. C., 1960. See also Wingo-Perloff, *op. cit.*

interact with each other. These spatial relationships and physical facilities comprise the central concern of city planners. Concern for physical transportation facilities is shared by the planners and the transportation engineers. Traditionally city planners and engineers have held no direct responsibility for the nonspatial and the nonphysical aspects of the community's life, these matters being the concern of other professional groups.

Such a professional division of labor seems quite tidy. The sheer magnitude of information and the sheer intricacy of contemporary theory that a man must absorb in preparing for work in any advanced field, precludes his becoming adept in very many fields. The state of current knowledge effectively demands increasing specialization. There is no disputing the improbability of a modern-day da Vinci.

And yet, actions taken by a specialist in one field may, because of ignorance of their latent repercussions, induce a series of unanticipated events in other fields. It is quite possible, of course, that these unexpected consequences might be so deleterious that, had they been anticipated and had their probable severity been preappraised, the initial actions would not have been taken.

Those who are responsible for making design decisions for less complex systems than the metropolis—for systems whose over-all organization can be readily comprehended—would not tolerate anything less than the exploitation of all existing knowledge to the fitting of designs for all its subsystems.

A suspension bridge is such a relatively simple system; a manufacturing plant is another; a missile is another; a corporation is still another. In each, the various specialists' design decisions for the various parts and for the various functions must be fitted to create a larger integrated design, lest the bridge collapse, the assembly line break down for lack of a part, the satellite fail to achieve orbit, or the corporation go bankrupt for imprudent programming of investments.

At this stage in our development our understanding of the metropolis comes nowhere near approximating our level of understanding of these simpler systems. We have not even identified all of its component subsystems, much less built satisfactory theories that might explain how they work and how they relate. But we do know a great deal.

Especially since the end of World War II, the metropolis has attracted the interests of many social scientists. Some have been examining the structure of its governments and the political processes by which they function; others have been investigating its social structure and the socializing processes by which different groups interact; still others have been subjecting its economy to careful analysis. This research has rapidly raised our level of understanding, and work in this field is just beginning to get under way in earnest.

But like the biologist who understands a great deal about the parts of organisms but still searches for the organizing principles, and like the physicist who has identified many different nuclear particles but still lacks a workable conception of atomic structure, so are students of the city still searching for the organizational structure of the metropolitan system.

Lacking this grand conception, however, we, no less than the physician and the nuclear engineer, can and must make decisions with only limited understanding of the consequences. Our burden, however, is to draw upon all that is known, lest, from unnecessary ignorance, we take actions having consequences we would not prefer.

At this point in time we know a great deal more about the consequences of building transportation facilities than typically is being drawn upon in making transportation decisions. The repercussions of a new urban freeway cannot yet be traced very far through the intricate maze of relationships that tie it to the metropolitan area's economy, its social structures, its political organization, its governmental fiscal structure, and its other subsystems. But they can be traced beyond the direct effects—beyond its capacity to carry forecasted traffic volumes and beyond its impacts on users' gas, tire, and time savings.

At the very minimum, as suggested earlier, the repercussions of new transportation facilities on land use patterns can be traced. In turn, some of the consequences of changes in land use arrangements can now be traced for their effects on the costs of doing business and for their impacts on family life. In addition, of course, its first-round impacts on governmental fiscal structure can be readily traced.

In the future, as we understand more about the network of relationships by which changes in one metropolitan subsystem influence another, we shall be able to carry the matrix of the analysis further.

The more consequences of a transportation decision that can be identified, the more likely we are to make rational decisions about transportation and, hence, about the long-term development of the metropolis as a whole. We can, that is, if we can first decide what it is we're after.

NECESSARILY POLITICAL CHARACTER OF METROPOLITAN DECISIONS

The fact that governments have assumed responsibility for building transportation facilities makes this kind of large-scale, repercussions analysis particularly necessary. If transportation decisions were the responsibility of many individual entrepreneurs, as most economic decisions are, the self-monitoring mechanisms of the market place would tend to limit the probability of highly risky decisions. Investments would proceed more slowly and with more caution, since few of the entrepreneurs would gamble on long-shot ventures.

If transportation facilities were not so costly and so influential, government-built facilities might be rationally justified with quite limited analyses of their consequences, perhaps even of the traditionally modest scale. If transportation facilities were not so permanent, their impacts, too, would be more perishable, and we might better afford the costs of mistakes. But transportation facilities are none of these. For better or worse, they are the responsibility of powerful and centralized governmental authorities; in their very nature, they are very expensive, very influential, and durable.

Although most transportation facilities are paid for in the short-run, their real costs and their real benefits are accrued over the very long-run future. The warrant for construction of any given facility, therefore, cannot be assessed except as the benefits can be expected to cumulate to outweigh the costs over the decades that follow construction.

Both the real costs and the real benefits, it should be clear, are not those that now enter the typical highway-users' cost-benefit analysis. They are the costs and benefits that, seeded by the facility, pile up throughout the metropolitan system.[8]

Costs and benefits are value-loaded terms, of course. In the con-

8. See Nathaniel Lichfield, "Cost-Benefit Analysis in City Planning," *Journal of the American Institute of Planners*, Vol. 26, No. 4 (November 1960), pp. 273–279.

text in which we use them, they refer to intangible values. It is relatively easy to construct operational definitions when we mean to measure only direct dollar outlays and direct dollar receipts or savings, as we do in measuring highway-users' expenditures and savings. It is quite another thing to assess the relative values of high-density central business concentrations versus dispersed patterns of offices and shops, or to assess the relative values associated with single-family residential developments versus apartment house developments, or those associated with a multiplicity of local governments versus larger and more centralized local governments—all of which are, in some measure, functions of the transportation system's design.

Difficulty comes with the fact that neither highways, nor business centers, nor houses, nor forms of government are valuable in themselves. Their value derives from their effectiveness in contributing to the successful functioning of the social order—in our context, the metropolitan order—and to the production of that most intangible and most important commodity, social welfare.

We do have some explicit and even quantifiable criteria against which we can appraise these kinds of effectiveness. Level of employment, level of per capita income, level of per capita productivity, level of education, and such negative indicators as incidence of illness and incidence of crime now serve as useful indices of successful functioning and of welfare levels in guiding the day-to-day decisions of governmental officials.

But there are many aspects of welfare for which we have no such quantified indices, many more for which we have no explicit qualitative criteria. We have, as yet, no wholly satisfactory ways of measuring the values of a park, for example, although there is clear community consensus that parks do contribute to human welfare.

The psychiatrists do not yet have a definition of mental health, although they are able to make judgments about individuals' relative levels of mental health. We cannot put a price on the returns that derive from free public education, but voters and legislators have few hesitations in judging the values to be great. Similarly we do not really understand what the values of an urban expressway might be, yet we choose to invest heavily in them.

Many of these intangible value questions are researchable; oth-

ers may never be. Many value considerations can be gauged by such indirect indices as per capita income, others will always be subject to qualitative judgment. But whether quantified or not, as we come to understand more about the meanings of human welfare, and as we come to understand more about the implications that various kinds of facilities and various kinds of events have for welfare, we shall then be more capable of stating explicit criteria for welfare.

As we succeed in doing so, we shall be more capable of making public decisions that are explicitly designed to accomplish explicit objectives. Specifically, we shall be more capable of making rational decisions about those transportation facilities that will induce chains of consequences that will improve the living conditions, the economic conditions, and the over-all welfare conditions of the people in the area to be served.

Lacking perfect knowledge concerning either the directions in which highest levels of welfare lie or the route for getting there, we must inevitably rely heavily upon the hypotheses of politicians. Our normative principles of government require that these, the most difficult, policy decisions be reserved for the elected legislators rather than for professional staff men within government; decisions made by experts from only partially informed positions are likely to be injudicious. But, of course, decisions made democratically by legislators operating from positions of ignorance are likely also to be imprudent.

This is no impasse. The problem defines its own solution. It is a mandate on the professional to examine all of the reasonable, alternative courses of action that lie open; to draw upon the total body of existing knowledge in an effort to trace the chain of consequences that lies implicit within each alternative course of action; to evaluate these consequences for all their probable value implications for the life patterns of families, for the conduct of business and industry, for the fiscal structure of government, and for whatever other effects may seem to be relevant and important; and then to pose the bundles of alternative actions and their evaluated consequences for legislative consideration.

The kind of analysis that this calls for, however difficult, is always possible. At any moment in time, whatever the state of the sciences, we can exploit the available knowledge for the purposes of increas-

ing the chances that our actions will lead to our goals. But to conduct this kind of analysis calls for a much broader image of our respective professional roles than we have been accustomed to.

Because we are all the inevitable victims of professional specialization, a comprehensive analysis of this kind demands a gigantic collaborative effort by men from a number of fields—the various social sciences, the various fields of engineering, and the various welfare professions, including public health, social welfare, public administration, city planning, recreation, and education. Such an interprofessional team can best bring the knowledge of the various metropolitan subsystems to bear on decisions concerning any one subsystem.

A full-scale effort of this sort might make possible what now happens, if at all, only by happenchance in the mind of the individual legislator—the formulation of an integrated bundle of policies for all aspects of the government's activities and responsibilities. Such a comprehensive set of policies cannot fail to increase the odds that any single decision will be better informed and to lower the odds that the effects of any single decision will be counteracted by those of another decision.

At the present time, when decisions on transportation facilities typically are made independently from other governmental decisions, the legislator has little assurance that an action here will not undo an action taken in another sector. But more important than that, since a decision to build a major transportation facility is, *in effect*, simultaneously a decision to induce all of its consequences in the other sectors, the rational legislator would prefer that these consequences be explicitly identified, so that he may know what it is he is deciding.

Such an appraisal of the long-term repercussions with their associated costs and benefits would furnish a highly valuable aid to rational decision-making. It would seem, as a minimum, that an evaluation of long-term consequences deserves at least equal consideration to a transportation facility's capacity to carry expected traffic loads and its impacts on user's operating costs.

The same can be said, with equal validity, of course, for all other kinds of decisions that professionals in government recommend. The school official, the sanitary engineer, the social-welfare worker, the

city planner, the fiscal officer—all are equally responsible for tracing the implications of their projects.

But the need for this kind of comprehensive, welfare-oriented, cost-benefit analysis is particularly great in transportation planning. There probably are no other actions that urban governments take that have larger repercussions and more lasting effects than do its actions to build transportation systems; there is probably no more powerful instrument of government by which plans for metropolitan development can be accomplished.[9]

SUMMARY

Our present level of understanding indicates that future land use patterns are not mechanistically predetermined by natural law but rather by the behavior of value-seeking people. The task of land use projection is therefore considerably more complex than the static-descriptive-positivistic models suggest.

These models are coming to be replaced by dynamic-behavioral-normative models that seek to explain how individual locators behave in the market; hence, how land use patterns of metropolitan areas develop and change over the course of time; and how changes in patterns might be so guided as to enhance over-all cultural and economic wealth.

Urban governments have assumed responsibility for conducting various kinds of service programs and for building various kinds of physical facilities that bulk very large as conditioners of the environmental qualities that locators seek. Government actions therefore have become important influences upon the spatial arrangements of places at which human activities are conducted and, indeed, upon the conduct of the activities themselves. Urban government therefore cannot escape the great responsibilities that are implicit in the actions it takes.

Moreover, urban governments are specifically charged with responsibility for leadership in matters of community development and community welfare. It is not sufficient that they merely follow market trends, that they merely satisfy increased demand for gov-

9. This conclusion is developed at greater length in Melvin M. Webber, "The Engineer's Responsibility for the Form of Cities," *Traffic Engineering*, Vol. 30, No. 1 (October 1959), pp. 11–14, 34.

ernmental services occasioned by population increases, that they merely predict the future and then accommodate to it.

Their task, rather, is to set the goals, the directions, for community development and then to take those steps that will shape the future to accord with those goals. This task calls for the formulation of attainable plans—not merely forecasts—that integrate all its goals and all its programs.

A key element in every urban government's plan for the future is its plan for the transportation system. Because a decision on a major transportation facility is so overlaid with critical welfare questions, nothing will do, short of a truly comprehensive effort at identifying and evaluating its implications and at fitting it into the total set of governmental plans.

Such an approach to transportation planning would shift our perspective from a view of transportation facilities as traffic servers to the more accurate view as a positive governmental force for directing the evolution of the metropolitan community in desired directions.

Two New Parking Systems

WILLIAM B. GLECKMAN

William B. Gleckman, an architect, who holds a degree of Bachelor of Architecture from the Massachusetts Institute of Technology, has also done graduate study at the Swiss Federal Institute of Technology in Zurich. At present he is writing his doctoral dissertation, a study of the automobile's impact on the form and architecture of cities. He worked on the first-prize project in the architectural competition for the design of the World Health Organization headquarters in the office of Professor Jean Tschumi of Lausanne, Switzerland.

THE lack of available parking space in urban and suburban areas, apparent to anyone who drives, has both far-reaching and immediate effects on many other persons. One means of remedying the situation is to provide new ways of utilizing land more efficiently to provide an increased number of parking spaces on a given site economically. The author submits two proposals to this effect: the "Park-a-Back" system for increasing the capacity of ground-level parking lots; and the "Silo" garage for efficient, multilevel parking in urban areas.

THE "PARK-A-BACK" SYSTEM

The "Park-a-Back" system is ideally suited for large open parking lots, such as are to be found at shopping centers, large industrial plants, commuter railroad stations, airports, and fringe lots in medium-sized cities. The system offers the parking-lot operator a new way of increasing the capacity of a lot at a minimum of expense. It enables two automobiles to be superimposed between two driveways, with the floor areas so inclined to the plane of the driveways that the upper parking space is accessible from one driveway and the lower parking space from the adjoining driveway. This arrangement makes it possible to effect considerable savings in ground area as compared to present normal ground-level parking arrangements.

The construction, relatively simple, requires a small amount of excavation for the lower space, over which is placed a prefabricated concrete or steel slab supported by precast concrete rigid frames at intervals of every two or three parking spaces. There is no need to

haul away excavated material; cut and fill are balanced so that the excavated soil from the lower parking spaces is used to raise the level of alternate driveways (see cross section, Figure 1).

Floor areas are sloped about 15 percent, which falls within the limits of most city building codes and is less of a slope than is to be found on many city streets along which cars are frequently parked.

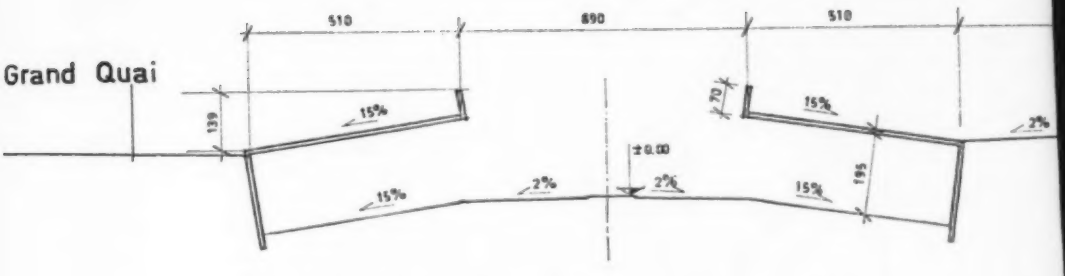
To avoid any possible damage caused by brake failure, buffers can be installed on the downward end of the lower parking spaces, and for the upper parking spaces blocking means can be provided, such as metal or concrete wheelchocks, steel chain with bumper hook or raised curb on the drive-in side. As a further precaution, the surface of the concrete slab can be grooved or left with the rough aggregate exposed to reduce the danger of slipping in icy weather. It should be noted that the lower parking space is well protected from the weather.

Besides offering the advantages of economy and of speedy erection with standard elements, the use of prefabricated parts makes it possible to demount the structure easily and move it to a new location for reassembly, should the need arise.

It is estimated that "Park-a-Back" can be installed at a cost of about $300 per parking space, including excavation, paving and drainage.

"Park-a-Back" Prototype. The photographs (Figures 3 and 4) illustrate a prototype for four cars which was constructed on land donated by the municipality of Oerlikon, a suburb of Zurich, Switzerland. All structural members, of precast, reinforced concrete, were cast in the contractor's shop over a period of three weeks. After site-work was finished (excavation, drainage and paving), the entire assembly was put together (bolted and grouted) in one day, with the help of a small, truck-mounted crane.

Comparison with a Normal Parking Arrangement. Dimensions necessary for 45°, 60° and 90° parking are normal for "Park-a-Back." The percentage savings in ground coverage as measured between the center lines of successive driveways are shown for each case. It can be seen that these savings range from 38 percent (90° parking for large American cars) to 54 percent (60° parking for large American cars). The over-all savings for a particular project will vary with the dimensions of the lot, as illustrated by the following examples.



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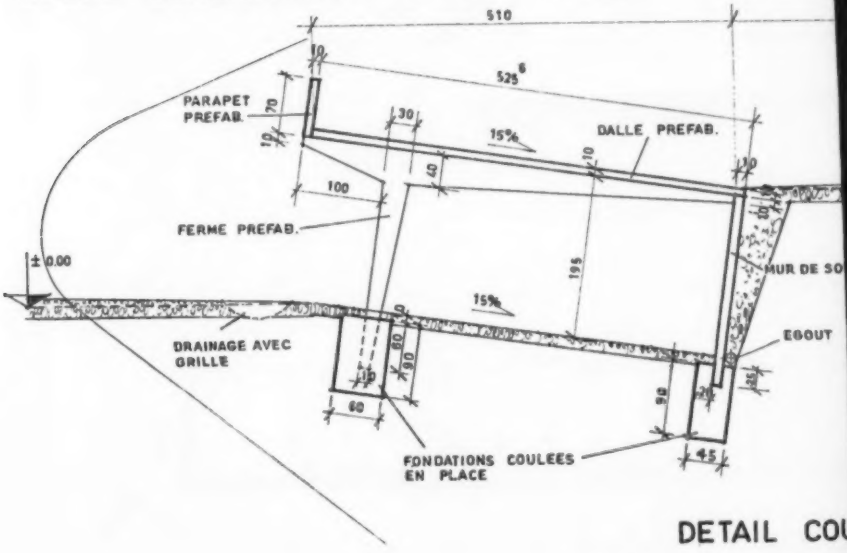

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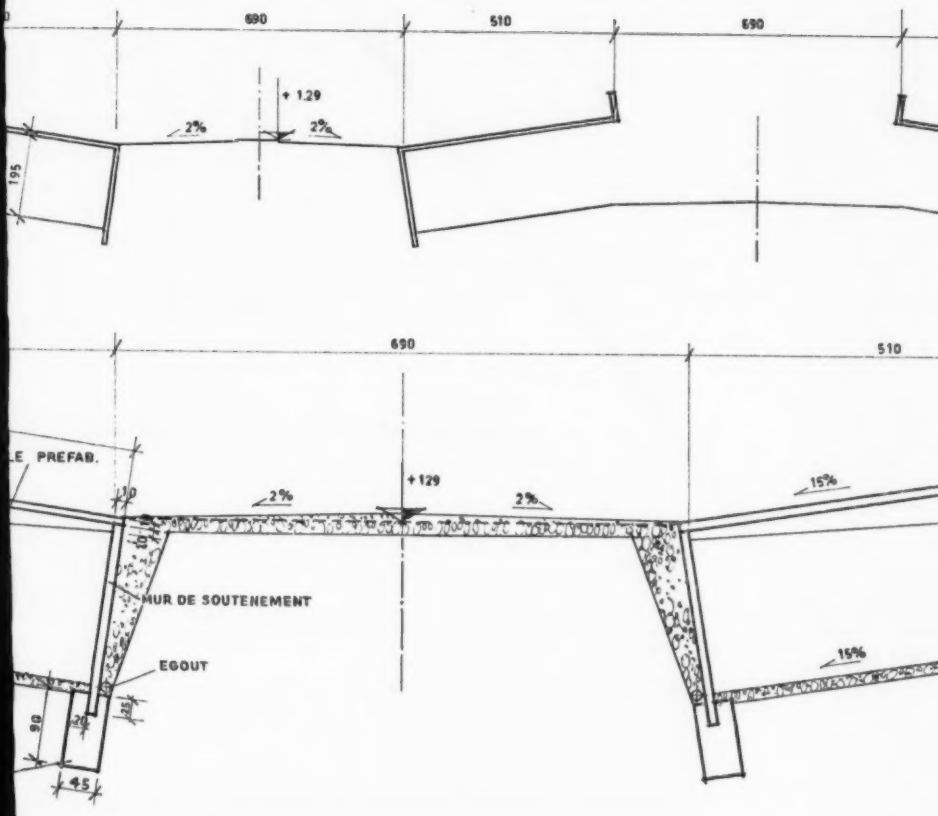
Figure 1. Cross Section



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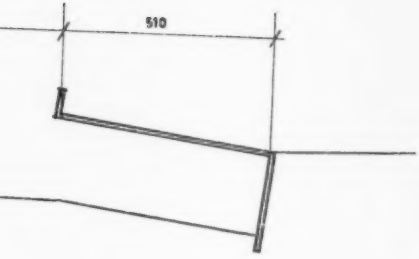
ure 1. Cross Section A-A (see Figure 2).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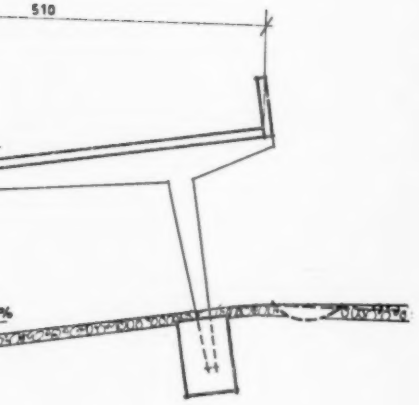
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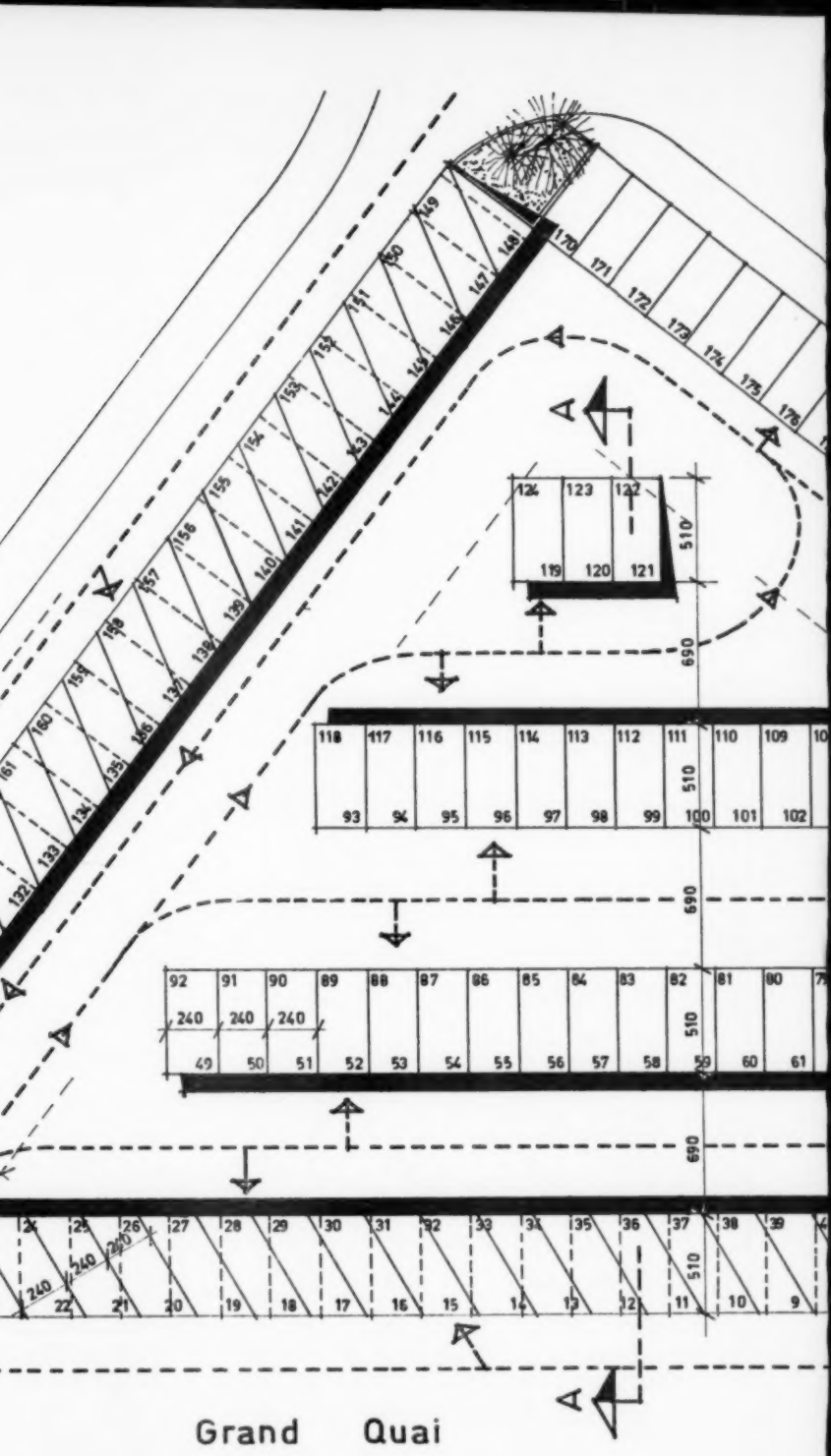
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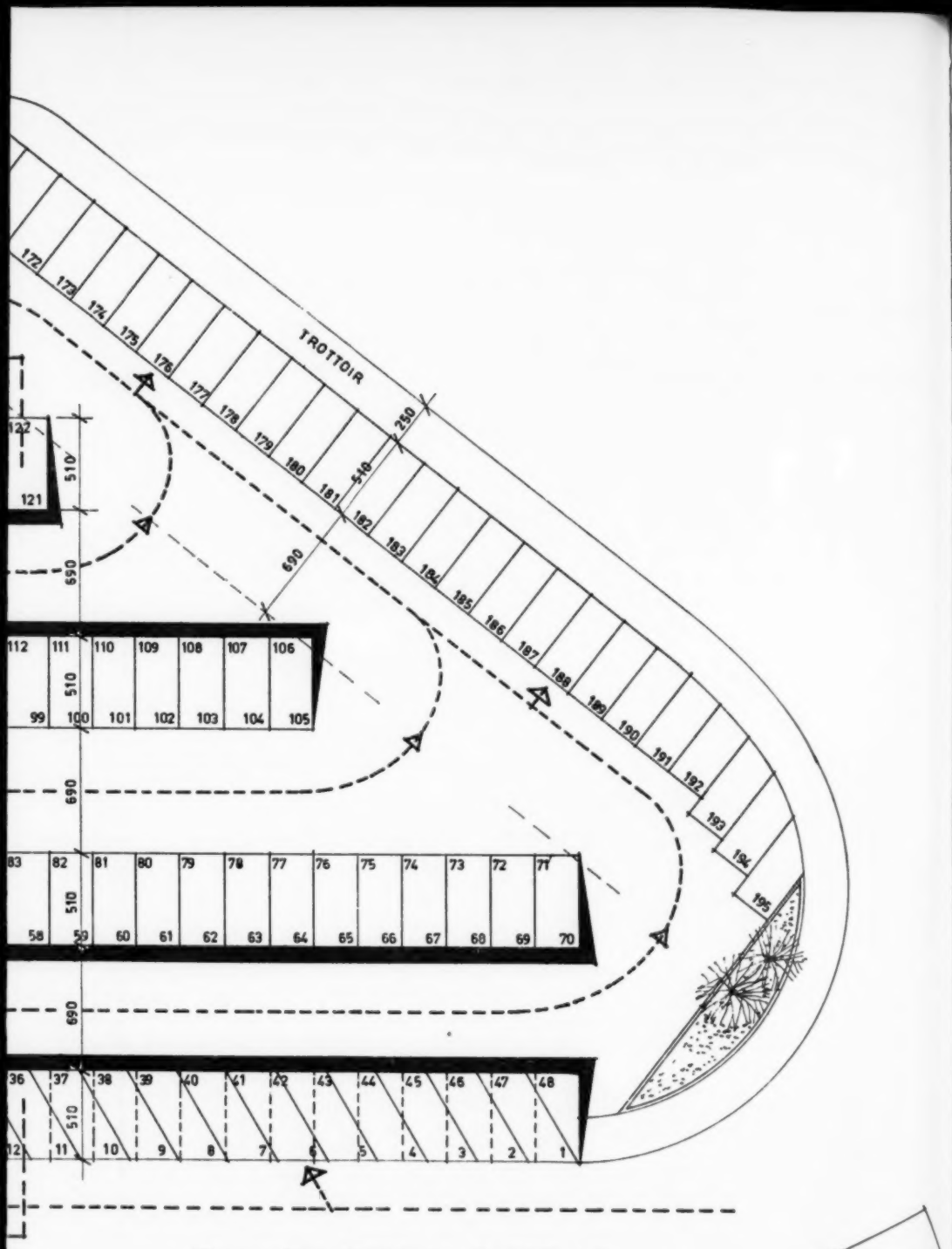


Figure 2. Plan of Parking Lot, Grand Quai, Geneva.

Figure 3. Prototype of "Park-a-Back " construction, Zurich

Figure 4. Sideview of "Park-a-Back" prototype, Zurich

A project is now under study by the Zurich traffic authorities for the construction of parking facilities on a vacant lot in the center of the city. A normal parking arrangement for this area would accommodate 234 cars, whereas an arrangement using "Park-a-Back" would accommodate 390 cars, an increase of 156 cars, or about 66.6 percent as compared to a normal, level-parking arrangement for the same site.

Parking Lot, Grand Quai, Geneva. Within this triangularly shaped municipal parking lot in the heart of Geneva, there is now parking space for 119 automobiles (see Figure 2). The total area of the site is 34,500 square feet which results in an average of 290 square feet per car. With the utilization of "Park-a-Back" system, 195 cars can be accommodated, with an increase of 76 cars, or a 64-percent increase in parking capacity. The area required per car has been reduced to 177 square feet.

The second type of garaging system is based on the premise that off-street, multi-level parking should be a simple and direct extension of the city's street system (see Figure 5). The principles of traffic flow which apply to the street should apply to the parking garage as well. The "Silo" can be thought of as a simple upward unraveling of the city's street system. It need be only an open-deck type of structure, which greatly simplifies construction and ventilation. There is no need to build a walled enclosure which would only increase the over-all cost without adding anything essential to the structure.

THE "SILO" GARAGE

The general form of this Silo is characterized by an access-ramp in the form of a rising helicoid with parking spaces on both sides, turning about a central axis, and concentrically surrounding a helicoidal exit-ramp which in turn surrounds the central opening. There is at least one point of tangency per floor (or turn of the helicoid) between the access- and exit-ramps, thereby making it possible for departing automobiles to turn onto the exit-ramp at every complete turn of the access helicoid. The exit-ramp can be either continually contiguous to the access ramp, or it can turn in the opposite sense.

Entering autos maintain a strict one-way circulation pattern as

they drive up the access-ramp, and departing cars a strict one-way circulation down the exit ramp. In this way, it is possible to achieve a complete separation between entering and departing automobiles and thereby to create a smooth traffic operation, especially important at rush-hour peak periods. A major defect of sloping-floor garages is thereby eliminated, that is, the congestion caused by two-way traffic which occurs particularly at the lower levels.

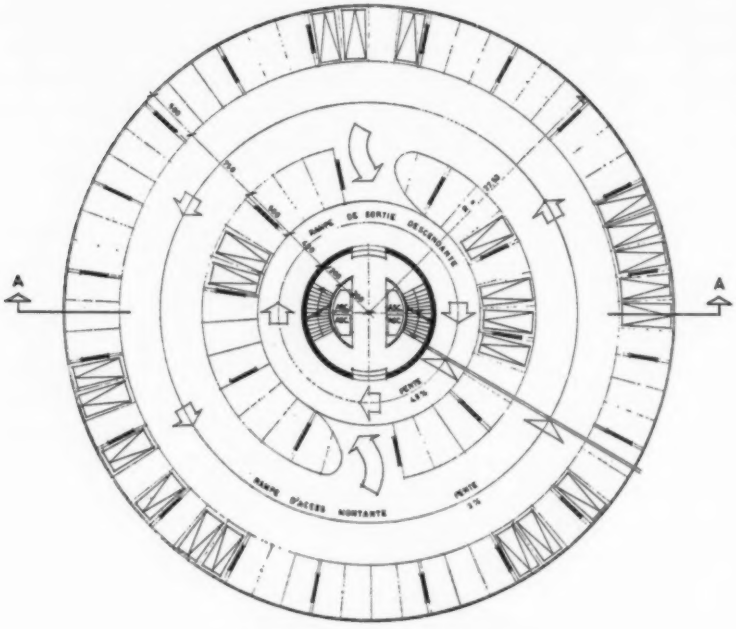


Figure 5. Silo Type Floor Plan

A further advantage is that there is no need to set area aside for access-ramps as is the case with flat-deck garages. With a floor-to-floor height of 8 feet, the slope of the access-ramp is slight, of the order of 2 percent, while the slope of the exit-ramp is only 5 to 6 percent. Cars are operated at 75° or 90° to the slope, which minimizes the chance of their rolling down. This Silo is well suited to self-service parking, and the flat slopes are not objectionable either for parking or walking.

The typical floor plans shown here have been designed for ut-

most spatial efficiency, taking into account the smaller dimensions of the new compact cars. The smaller compacts can be parked along the interior stalls, while the larger American cars are parked in the outer stalls. The radius to the outer curb of the exit-ramp is 29 feet 7 inches, with a ramp width of 12 feet 3 inches, thus enabling even the largest American models to descend without difficulty.

In the circular variation, the area per floor (or complete turn of the helicoid) is 24,800 square feet for a total of 86 cars per floor. This amounts to an average of 288 square feet per car (access- and exit-ramps included), exactly the same as for a ground-level parking lot, and approximately 20 percent less than the average area per car for the majority of multi-level parking garages.

Construction of a Silo of this type can be carried out economically. Concrete for the floors can be poured on a system of movable, track-mounted form work which moves upward as the work progresses, while being supported by the previously completed structure below. Also, the constant radius allows the continual re-use of metal forms.

Obstructing columns are eliminated from the access-ramp and parking stalls. This is achieved by means of a flat, pre-stressed concrete floor slab spanning 60 feet, with a depth of about 15 inches; the supporting columns are located just inside the interior parking stalls and just to the outside of the exterior stalls. In this way there are no unsightly beams, resulting in a smooth, uninterrupted flow of the upward movement of the ramp.

The Silo lends itself equally well to underground construction, in this case, with a descending access-ramp.

As the plans indicate, it is possible to build this type of garage either in a circular or a rectangular form, or in any intermediate form (ellipse, polygon). On the ground floor there can be a service station with control points both at the entrance and exit of the Silo, thus requiring a minimum of operating personnel. There is no necessity for automobile elevators, although if desired these can easily be installed in the central opening.

APPLICATION TO URBAN PLANNING

Carrying the idea of a parking Silo as a simple, vertical unraveling of the city's streets a step further, it can be seen that offices, stores, hotel or motel rooms, or other kind of commercial premise

can be arranged around the periphery of the Silo. The average driver desires to store his car near his destination and to spend a minimum of time parking and un-parking it. His wishes can, at present, be most ideally satisfied by street-side parking at the entrance of the building to which he is going. When a great number of drivers seek the same destination, it is evident that their parking demands cannot be satisfied within the existing street pattern.

However, if the maze of city streets, together with their street-side commercial premises, were to be vertically unraveled, it would then be possible for a greater number of drivers to park at their destinations. One can picture an urban motel or a commercial office complex of this type where each guest or tenant can park his car near his door. In this way, parking requirements would be treated as a necessary building utility, built into the structure in much the same way as gas, water, electricity, and other utilities. This could contain certain implications for the shape of the "automobile metropolis," characterized by a number of ziggurat blocks, each serving a different specific need. There could be ziggurats functioning as administrative centers, shopping centers, theater and recreation centers—in fact, a proper number and variety of these buildings could fulfill the services and functions demanded of a modern metropolis.

Licensing Drivers

JOHN C. KERRICK AND DR. JOSEPH P. HENNESSEE

John C. Kerrick, Director, the Driver License Program of the American Association of Motor Vehicle Administrators, served more than thirty years in the Oregon Department of Motor Vehicles. His experience includes service as Director of Motor Vehicle Registration and years as Director of Driver Licensing and Driver Improvement. He was formerly Chairman of the A.A.M.V.A. Committee on Driver Licensing and Driver Improvement, and active for many years in the driver licensing field on a national level.

Dr. Joseph P. Hennessee, Director of Driver License Personnel Training, A.A.M.V.A., was formerly Assistant Director of the Institute of Government and Assistant Professor of Public Law and Government, University of North Carolina. While at the Institute of Government, he worked closely with the North Carolina Department of Motor Vehicles as a consultant on driver license matters. In this capacity he aided in the development of a sound program of basic and in-service training for driver license examiners and highway patrolmen. He has written manuals for both license examiners and hearing officers.

A CERTIFICATE in almost all bill-folds or purses, commonly called a driver's license, has been fittingly renamed *Our Most Neglected Safety Device.*

This descriptive phrase, widely accurate in the past, is unfortunately accurate today in many states.

It must not continue so.

It will not continue so when the driving public realizes that in the field of driver licensing there is available an administrative program which, properly developed and fully implemented, can contribute more to traffic safety than can any other single endeavor—at comparatively small cost.

The slow and lagging recognition of powers inherent in driver licensing is understandable when considered in comparison with other developments of the traffic problem. A demand for engineering progress has been loud, strong and continuous since the beginning of the automotive age. The demand is still in evidence.

It calls for better cars, more and better highways designed to

move more vehicles more rapidly. So great and insistent is this demand that cost appears as secondary. This is something the public wants. Each driver foresees benefits and he is willing to pay for them.

It has been more difficult for car-owners and drivers to recognize personal advantages growing out of driver regulation and control. These have often appeared as restrictions; grudgingly accepted but seldom welcomed and never demanded with force in any way comparable to demands in the field supplying direct benefits to the motorist.

Among regulation and control measures we include rules of the road, vehicle registration requirements, traffic law enforcement and driver licensing, the latter too long regarded as an unwelcome and unpromising stepchild more subject to ridicule than to respect.

This unhealthy condition may be traced to the humble and colorless *origin* of drivers' licenses. While they have been described as *licenses*, many of the first licenses might have been better designated as drivers' "receipts" because they amounted to little more than evidence that the licensee had paid a small fee to a licensing agency. One such license could be obtained by personal application or mail for a fee of twenty-five cents. To establish his qualifications and his eligibility for this license the applicant stated that he had "at least five days experience" as a driver. Such license was to remain valid for the life of the licensee unless suspended or revoked—strange new terms to the early-day driver but not terms causing him much concern because they were seldom applied.

DRIVING A MATTER OF PERSONAL LIBERTY?

The driver bought his license. In so doing, he complied with a legal requirement of the time but he recognized little relationship between the purchase of a license and the manner in which he operated his automobile. Driving he regarded as a matter of personal liberty subject to regulation and control by no one but himself.

The traffic accident problem had not yet come into being but the pattern was developing. It was recognized by at least one observer of the day who, upon seeing an automobile stirring up dust at the reckless speed of fifteen miles an hour, remarked, "One of those machines is going to kill somebody, someday." The most understated prediction of all time.

But the race was on, with its demands for better highways, more cars, more power and more speed. All have been supplied. The cost in human casualties has been given little more than cursory consideration.

Had the cost been given adequate consideration, the requirements of driver-performance would have kept pace as the problem developed and we would not now see our people accepting forty thousand deaths a year as a necessary price of motor vehicle operation. To those sincerely concerned this price rightfully and plainly appears as both exorbitant and *needless*.

Our present position is one of attempting to bring driver regulation and control into proper perspective and assign to it the role it should have maintained at the beginning of motor vehicle transportation. This is a most difficult assignment but not an impossible one.

Driver licensing, as we use the term, involves many activities other than the issuance of license certificates. A more appropriate term is driver control through licensing procedures because the regulation and control of drivers in the interest of safety represents the *only* purpose of driver licensing. It should never be regarded as a revenue-producing activity.

IMPOSES RESTRICTIONS ON THE UNQUALIFIED

Complete development of driver control through licensing procedures will impose no restrictions or limitations whatever upon the qualified driver who complies with provisions of the laws governing operation of motor vehicles.

For the driver who cannot or who will not operate safely within the law, a fully implemented licensing program will certainly result in restrictions and limitations. They will be severe limitations, in some cases, but they will result eventually in a freedom from fear that cannot be enjoyed now by those who share the roadway with unpredictable and unsafe operators.

How can this be accomplished?

Let us envision a fully implemented driver licensing program, authorized by sound legislation, administered by fully qualified personnel, having the complete support of adequate law-enforcement and judicial agencies and—most important—supported by the power of public opinion.

First it must be recognized that almost all traffic accidents, so called, are caused by human failures. They result when a driver is either unable or unwilling to abide by well-established rules of good driving.

An accident still is commonly regarded, not as the result of an offense or a mistake, but as an unfortunate incident, of concern to no others than those directly involved. From those *not actually involved*, the drivers whose blunders caused trouble often received sympathy more than condemnation: "It was an accident."

DEMONSTRATED ABILITY TO DRIVE SAFELY

Returning to consideration of a fully implemented licensing program, complete development of the powers inherent in driver license legislation and administration would mean that the privilege of driving would be limited to those whose demonstrated *ability* to drive safely could be made an authentic matter of record before granting the driving privilege. It would mean, also, that the driving privilege would be *retained* by such drivers only so long as they continued to demonstrate both an ability and a willingness to operate safely in compliance with all laws directing and regulating the movement of traffic.

Does that appear unreasonable? To some it does. That accounts in large measure for the retarded progress of driver licensing and for the resulting failure of drivers to accept safe driving as an obligation.

By comparison with the ideal situation described, in which the unfit are eliminated or restricted, it might appear that little or no progress has been made to date.

Yet by comparison with the days of over-the-counter sale of licenses, a great deal of progress has been made, at an accelerated rate during recent years, even during recent months.

Every state now requires a qualifying examination of some type before issuance of an original license to drive. No state now issues a license of the valid-unless-suspended-or-revoked type. No state has, as yet, had either the personnel or the facilities needed to conduct examinations of all drivers at the time of license renewal. In twelve states, however, it now is impossible to renew licenses by mail. A personal appearance is required.

In six such states a vision test is required prior to license renewal.

In six other states all of the inside tests are required at each renewal period with the road test (the actual driving demonstration) being required at the discretion of the licensing agency.

As for quality and effectiveness of the average license examination, we note in this area, too, that commendable progress is being made even though much remains to be done.

TESTS FOR DRIVERS

The average examination now conducted to establish the qualifications of a driver consists of answering approximately twenty written questions on current traffic regulations and license requirements (seventy percent represents a satisfactory grade in most states); a test to disclose the applicant's ability to understand road signs; a recording of the applicant's vision; and an actual driving demonstration.

The average road test (the driving demonstration) is completed in slightly more than fourteen minutes. It can include only enough to disclose that the applicant possesses at least the basic skills needed to operate a vehicle with reasonable skill and confidence under normal traffic conditions. Under present circumstances it can do no more.

The vision test formerly conducted by more or less haphazard use of the familiar wall chart now is conducted in thirty-seven states by using instruments designed for the purpose. Progressive administrators are working closely with professional authorities in the fields of optometry and ophthalmology to improve the quality and the validity of vision-screening by license examiners.

Progressive administrators also work with public health officials and other representatives of the medical profession to gain more knowledge of physical and mental abilities required for safe driving.

DEFINITE PROGRESS

All of these activities represent definite and constructive progress in the field of driver licensing. Yet in the future, present-day standards and procedures will in retrospect be viewed as little more than elementary pioneering ventures. So much remains to be done.

Forty-five states now have personnel assigned to driver improvement, the program designed to reach drivers whose records of

chargeable accidents or convictions following traffic-law violations indicate that the offending drivers are unable or unwilling to exercise the judgment needed for safe motor vehicle operation.

The term Driver Improvement is comparatively new. It probably is a term now quite meaningless to most drivers. It represents, however, the most significant of all developments in driver control through licensing procedures. Already, it has become well known to drivers whose records cause them to appear in driver license files as repeaters or as problem drivers.

Under a well-organized driver improvement program the court in which a driver is found guilty of an offense involving a moving violation of traffic laws promptly reports such conviction to the licensing agency. There it is immediately entered on the offending driver's record.

In the same way, the licensing agency records each accident in which a licensee becomes involved as a driver. It follows that the performance record of each driver becomes readily available at any time. It can be used by the licensing agency as a basis for such action as may be needed to correct faulty driving practices of the offending driver. If a questionable driver fails to make corrections, his driving privileges become subject to restriction or suspension.

A WEAKNESS LONG RECOGNIZED

Such is driver improvement. It corrects a weakness long recognized in the original concept of driver qualification. Originally all emphasis was placed on the examining phase.

That phase retains its importance in a well-balanced program but it does not in itself reach the driver who performs badly *after* completing the original examination requirements. The driver improvement program can reach such offenders and correct faulty driving or it can terminate driving privileges.

Since motor vehicles have long since passed from the strictly pleasure category and are regarded as economic necessities, the administrative authority to grant or to deny driving privileges involves a responsibility of major proportions. In a few states this responsibility is taken so lightly that it is farmed out to local officials who often treat it as a side line, a revenue producer or an activity permitting easy political contacts.

Only seven states remain in which the licensing of drivers is delegated to local officials over which the licensing agency exercises little more than token control.

In more progressive states the licensing of drivers, the examinations, the driver-improvement activities, the suspension and revocation procedures and all related functions are being recognized as duties to be entrusted to well-qualified and highly trained personnel only. For this reason, specific provisions for the training and development of driver license personnel were included when the American Association of Motor Vehicle Administrators organized its nation-wide driver license program in 1960, under a grant from the Insurance Institute for Highway Safety.

The driver license program, conceived by L. S. Harris, Executive Director of the A.A.M.V.A., was designed to hasten correction of weak and faulty licensing methods and procedures. The present staff includes a program director, three field representatives and a director of driver license personnel training.

All are men with years of experience in the field of driver licensing. The three field representatives work directly with agencies which, in their respective jurisdictions, are charged with responsibility for administration of driver-license laws. Their objective is, as mentioned at the outset, to develop recognition and implementation of the constructive contributions that can be made to traffic safety by well-planned and well-administered driver licensing programs.

Personnel engaged in driver license activities at the top administrative level sometimes assume their responsibilities without full knowledge of driver license laws or driver licensing practices and procedures. Administrative appointees, often political, sometimes possess little special knowledge or experience in driver license matters at the time of appointment.

Heretofore, such knowledge and skill have been gained through trial-and-error experience methods. Too often, under our political system, continuity in administering our driver license programs has been lacking with outgoing officials departing with their knowledge and experience and with new officials coming in to begin anew the self-educating process.

Officials thrust inexperienced into positions administering our

driver license laws have been, in most instances, men of ability and courage. As they learned their duties they realized the importance of driver control through licensing. Almost without exception, they have become dedicated men. Dedicated to driver licensing; dedicated to highway safety.

STANDARDIZED, CONTINUING PROGRAMS

These men have realized the need for standardized and continuing training programs and have chafed because of their unavailability. Through their efforts training programs for examiner level personnel have been established in many states. The caliber of examiners and examinations has been improved and continues to improve. With this improvement has come improved public service; improved efficiency of operation.

Examiner positions are beginning to be professionalized. More and more administrative continuity is being achieved by removing examining and supervisory examining positions from politics.

With the explosive increase in registered automobiles and licensed drivers, however, and the corresponding increase in the number of examiner personnel needed to administer driver license programs, the need for training, particularly on the examiner level, continues.

The increasing mobility of our people coupled with the shrinkage in distance calls for uniformity in training together with uniformity in driver license laws.

This is not to imply that no training in the driver license field has been available. The A.A.M.V.A., beginning in 1951, provided training for administrative and supervisory personnel at the Traffic Institute of Northwestern University through two four-part courses offered over a period of eight years. The A.A.M.V.A., through the University of North Carolina, and San José State College has also provided training on a state and regional basis. No particular coordination between such efforts, however, was effected prior to the current year.

Considerable progress can be reported. Last August, the A.A.M.V.A. offered a two-week school for driver license administrators at the University of North Carolina. This school was attended by forty-seven administrators from nineteen states, Puerto

Rico, and Israel. In October, a second school, for supervisory personnel, was held at Northwestern's traffic institute. This school, lasting for three weeks, was attended by seventeen chief examiners and supervising examiners from twelve states.

THE BIG TRAINING NEED

The association's training program is not limited to formalized training on university campuses. During the past year two state-level pilot training courses were planned and executed: the first of these, a three-week basic course for examiners in New Brunswick, Canada; the second, a series of two in-service training schools for examiners, in Arizona.

In addition, the association's field representatives participated in in-service training courses in Alabama, Iowa, Minnesota and Wisconsin. Personnel limitations prohibited participation in training programs in other jurisdictions.

The big training need, as expressed by administrators from across the country, is on the examiner level. This need cannot be met by the association under present personnel and budgetary limitations. Nor is it possible or feasible to transport examiners in large numbers to centrally situated national or regional training courses, even if they were available.

This need must be met. To meet this need the A.A.M.V.A. will, during the present year, provide instruction for examiners and driver improvement instructors and training personnel. The objectives are twofold: first, to develop new and improve existing programs of basic, in-service, and on-the-job training for driver license and driver improvement personnel; and second, to develop competencies in the organization, preparation, and presentation of basic, in-service, and on-the-job training programs.

In short, the objective, this year, is to teach teachers; to develop within each jurisdiction a training nucleus capable of planning, with such assistance as may be necessary, and operating basic, in-service, and on-the-job training programs.

This instruction, on a national basis, will be offered at three selected universities—universities selected because of their facilities and because of their recognized leadership in training driver license and driver improvement personnel.

The course of instruction at each of these schools will be identical and will represent the combined thinking of the representatives of the three universities concerned. This is a joint enterprise sponsored by the association, which will for the first time provide standardized training within the reasonable geographical reach of each state.

Attendance at each school will be limited to personnel responsible for departmental training programs and to personnel slated for assignment to departmental training program planning and departmental training program instructional duties.

Subjects to be covered in each school will include public speaking, introduction to training, determining training needs, development of training programs, teaching procedures and techniques, practice teaching, training program management, and, in conclusion, a complete in-service training program planned, developed, staffed, and presented by those in attendance.

UNLOCKING THE STOREHOUSE OF KNOWLEDGE

This program is based on the fact that there now exists within many jurisdictions a body of experience and knowledge locked within the minds and bodies of key personnel at the staff level. The object of this training is to unlock this storehouse of knowledge and experience and to make it available for constructive state-level training.

Training for examiner instructor and departmental training personnel has been planned to meet the expressed needs of driver license administrators across the country. Future training offered by the Association will continue to meet the training needs expressed by member administrators. Present plans call for an expansion of the Association's training program in future years to provide standardized training on a recognized university campus in each of the four geographical areas of the United States.

In addition to the formalized training program listed above, the association will continue to provide advice and assistance in the planning and presentation of driver license training programs on the state level. Already plans are under way to provide such assistance in several states. Time and personnel permitting, the service will be extended to others.

The goal of a completely implemented and effective program of driver control through licensing procedures involves a program of direct concern to more than eighty million of our citizens who regularly operate motor vehicles on our streets and highways. It is reasonable to assume that almost all of these eighty million drivers have a personal desire to reduce the dangers of traveling in present-day traffic, and in the vastly more complex traffic which must be anticipated in the near future.

The desire is apparent. The course of action is not so well defined. Many approaches have been tried. Some have been quite effective. However, the basically simple theory that driving privileges should be granted only to those who can and will *drive right* has not been tried.

The potentially powerful and effective driver's license remains basically an ID card, sometimes handy in establishing a birth date or in cashing a check. It remains our Most Neglected Safety Device.

The Ideal Highway Department

ROY E. JORGENSEN

Mr. Jorgensen received the degree of Bachelor of Civil Engineering at the University of California in 1930. His professional record includes positions with the U.S. Bureau of Public Roads, the Connecticut State Highway Department, and the National Highway Users Conference where he was engineering counsel. He has also taught at the Bureau of Highway Traffic of Yale University. On May 1 of this year, Mr. Jorgensen opened his own office in Washington, D.C., specializing as a highway management consultant.

THERE is a saying among old-time, career highway administrators that a new commissioner knows more about highways his first day in office than he will ever know again.

Some years ago I would have presumed to lay out the organizational structure for an ideal highway department. I would have said that there is no reason why there should not be a one best way to organize, and that all departments should be striving to reach it. After all, the departments all have the same basic function—to develop and operate an adequate highway system.

Today, after more than five years of working with representatives from all but three state highway departments at the National Management Conferences, sponsored by the American Association of State Highway Officials and the National Highway Users Conference, I know my early conviction was all wrong. There is no one ideal highway department organization. And the principal reason, in a word, is "people."

If people were as alike as one model of auto coming off the production line, there would be reason to expect an ideal form of organization to fit the job to be done. But people are not alike.

Most important—you do not start with a fresh group of new people and a brand new endeavor. You start with people on the job, who have work habits and relationships that have been developing over long periods of time. You start with a big functioning organization involved in a great variety of work, where some individuals have had only very specialized experience and training. To set up a presumed ideal organization, without regard to what is now function-

ing and the capabilities and limitations of people you now have, would be unrealistic and fraught with hazard.

This is one thing we concluded about building an ideal organization—you should start from where you are and with what you have now.

Another conclusion we reached about the structure of an organization is that it should be subject to continuing review and adjustment rather than to an occasional massive overhaul.

This does not mean that a highway department should be changing from day to day or week to week. But it does mean that we should not remain unequivocally committed to a set organization pattern. Chances are that if it's been fixed for several years it needs some adjustments rather badly.

Further, the making of organization changes generally should be handled with delicacy rather than as full-scale reorganizations. This is not to say that there may not be times when full-scale reorganization is necessary. But if the policy of continuing review of the organization and its functioning is established, adjustments will be made from time to time on a limited basis rather than as major changes at long intervals.

As a result of our experience with the problem of organizational structure, we prepared an outline for highway department organization review.

OUTLINE FOR ORGANIZATION REVIEW

Step 1. Orientation and Research

A. *Management seminar for bureau and division heads, district engineers and other key management personnel.*

This serves two purposes. First, it brings the key personnel of the department into the review program, and encourages their understanding and co-operation. Second, the seminar discussions reveal department problem areas.

B. *Defining of position descriptions for principal jobs as they now exist.*

This is the starting point. Regardless of what the organization chart shows, individuals and their relationships with each other determine how the department actually operates. This is established by questionnaires and interviews.

C. *Inventory and evaluation of management personnel.*

Just as individuals are the principal determinants of how the department now operates (B above), so do the people available for management jobs determine what can be done in shaping the organization for the future. An inventory, particularly of professional and supervisory personnel at the lower levels, provides information on their experience and training and an appraisal of their potential for management jobs.

D. *Analyzing problem areas, functional assignments and position relationships.*

This, in effect, is a summarization and evaluation of the results obtained under A, B and C.

Step 2. Interim Review

A. *Presentation to department head of analysis of existing operation.*

This shows him what he has now. It shows the problem areas and why they exist.

B. *Review of preliminary recommendations with department head.*

This involves consideration of various suggested alternatives of organization and procedure changes, and methods of effecting them. It affords an opportunity to incorporate the department head's judgment and experience background into the organization review.

Step 3. Formal Report

A. *Definition of recommended organization structure.*

This includes a conventional organization chart and a general description of functional assignments.

B. *A recommended management guide.*

This provides positions descriptions for all key jobs in the department. It outlines the function and the responsibilities associated with each job, including a clear definition of relationships with other functional areas.

The management guide is the key element of the organization review. It sets up an operating charter for each key position. It eliminates duplications of effort and provides the basis for co-operative endeavor on a logical and consistent basis.

C. *Schedule for making organizational changes.*

Such changes in organization structure and procedure as are recommended must be scheduled so as to minimize their impact on the department operations, and to take account of the availability of qualified personnel. Some of the desirable changes may be attainable promptly while others may have to be scheduled for accomplishment more gradually.

Two elements in the outline require some comment.

Seminars: The first step in the outline, the seminars, should be scheduled for at least three days, preferably a week, at a location away from highway department offices.

Rather than one seminar for all key people, it is suggested that there be two groups and two separate seminars. Doing this has several advantages. It results in smaller groups which encourage more individual participation in discussion, and leaves half the staff on the job while the others are away. It permits subordinates to be scheduled for a seminar separate from their immediate superiors, which is highly desirable.

Position Descriptions: Conventional line diagrams are standard practice for showing the organizational structure. However, they really do not provide much more than a framework for an organization.

How the organization actually functions requires another dimension—descriptions of the function, responsibilities and relationships of key positions. These, it will be found, may differ greatly from what might be assumed from the simple line chart. Furthermore, they may differ greatly from what the top administrators may have intended or desired in the way of function delegation and relationships.

In summary, the ideal highway department should be a dynamic organism geared to the utilization of new techniques and adapted to the fullest utilization of its greatest asset—the people who make up the organization.

THE PEOPLE

The foregoing discussion dealt with a procedure for gearing the organization structure to the people in it. This is one side of a two-sided problem.

What do we do about developing the people to assure efficient functioning of the organization—the other side of the problem? And what do we do about developing people who will then give us latitude for desirable organization changes in the years ahead?

Are we building a strong reserve strength—a Yankee baseball club "bench," so to speak?

Or are we just letting the development of people take care of itself, trusting the "hard knocks" of experience to give us our management team for tomorrow?

Some of us may be inclined to view our highway accomplishments with pride and say the "hard knocks" approach has worked in our case; why get involved with these new-fangled ideas? But development through experience is not so easy when the organization has grown into a large, complex operation with increasing numbers of highly trained specialists. Twenty-five years ago we were all general practitioners. Today that isn't the case. Furthermore, if we are completely frank, there are a few old-timers who would not admit to inadequate preparation and training for management responsibilities.

What then does a highway department do?

As with most management problems, there is no one answer.

There are scores of programs and ideas for development of executives. In our activities on the co-operative AASHO-NHUC National Management Project, we have been inclined to go slowly. The highway officials have demonstrated a great enthusiasm and keen recognition of the need to do some things in the interests of management improvement. Our first interest is to sustain the enthusiasm and encourage the interest of the officials. So we do not want to get something going that might not prove out in a reasonably short time. We think limited and readily attainable goals should be the first objective of any state highway department program for developing people.

During the past year we outlined a suggested approach as follows:

Developing People Project: One of the major objectives of the highway department should be to build an organization of capable, well-trained individuals at all levels, to give every employee opportunity to develop to his fullest potential. It is suggested that a highway department policy be formulated which gives total organizational support to the attainment of this objective.

It is recommended that immediate goals be set as follows:

1. A manpower inventory to include all executive and supervisory employees.

2. On-the-job development of employees with particular emphasis on superior-subordinate relationships such as counseling, coaching and planned delegation.

3. An appraisal of training and experience needs.

4. Establishment of a performance appraisal procedure.

The manpower inventory gives a codified record of all employees, with their education and past work assignments fully detailed. It should be so designed as to provide ready summarization of the character of experience and the quality of performance. Historic data on the latter may not be fully available, but provision should be made to assure complete information in the future.

On-the-job development through superior-subordinate relationships is the backbone of any successful development program. Significant results may be achieved through the establishment of regular superior-subordinate meetings, and the use of "How Am I Doing" counseling techniques, along with coaching and planned delegation.

The appraisal of training and experience needs should be worked up through analysis of individual work records and by personal interviews. It provides the basis on which to organize appropriate training and development programs geared to achieving the stated objective of developing people.

Establishment of a performance appraisal procedure lays the groundwork for much of the future development of people activity. It is suggested that this be started first, with one or two positions in the department as a pilot operation.

SUMMARY

The approach to attainment of an ideal highway department must be made from two directions.

First, the framework must be fitted to the existing operation and the people who are now making it work. The framework must be supplemented, too, with a management guide which clearly defines functions, responsibilities and relationships for the key positions in the department.

Second, the development of people must be made a basic objective of the organization. Every employee should be given an oppor-

tunity to develop to his fullest potential. The organization should strive to have capable, well-trained individuals at all management levels in the department, with a reservoir of talent available for advancement as opportunity permits.

Serving Motorists on The Interstate System of Ohio

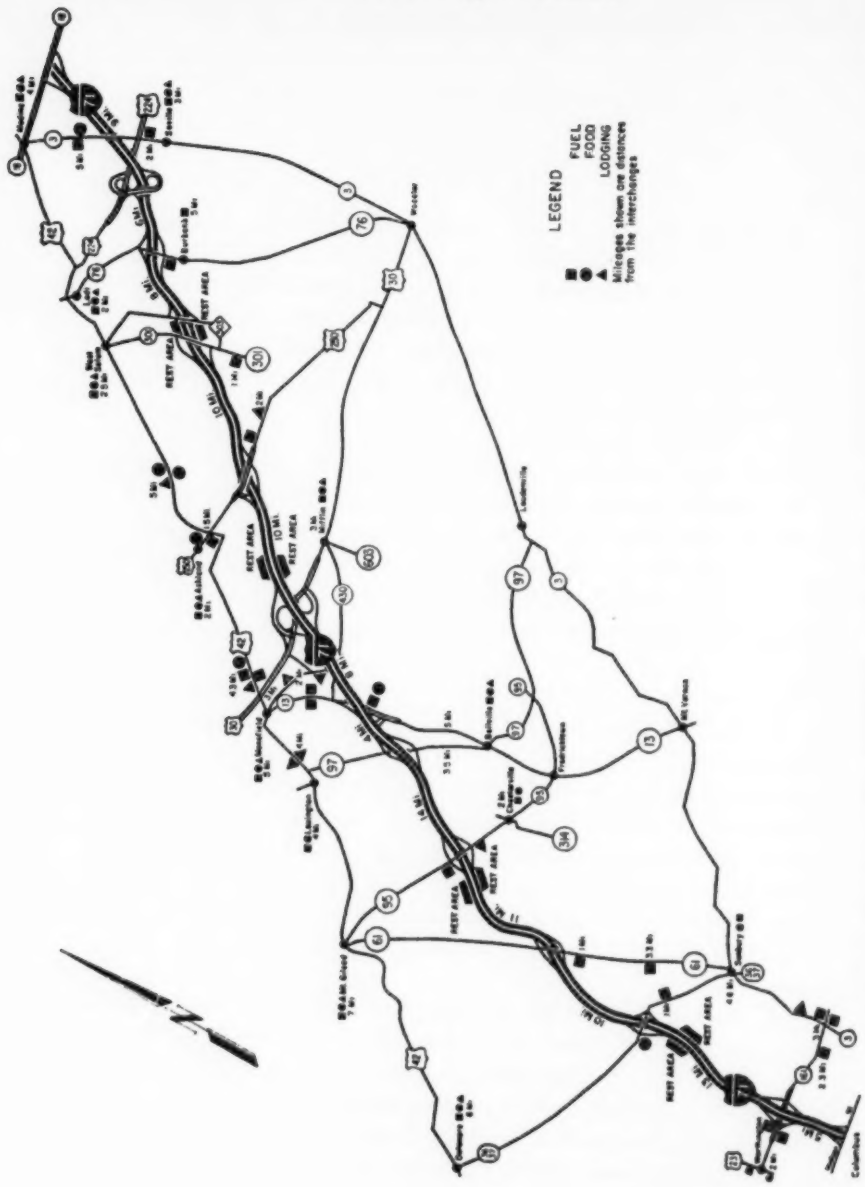
JAMES V. MUSICK

Mr. Musick, Engineer of Traffic in the Ohio State Highway Department, has also been Chief Traffic Engineer for the city of Columbus and Assistant Traffic Engineer in Cincinnati. He has a Bachelor of Science degree in Civil Engineering from Yale University. A member of the Institute of Traffic Engineers, he is president of its Ohio section and serves also on the traffic committee with the American Association of State Highway Officials and the Highway Research Board.

FIFTY years ago it was not unusual to see my neighbor load his automobile for the family "all day" trip from Columbus to Cleveland with spare containers of gasoline, oil and water, assorted wrenches and tools, a tire pump, spare tire tubes, chains, boxes of food, and most important of all a compass. Road maps, roadside facilities and motorists' services were words not then in our vocabulary.

Five years ago, my neighbor's son was more concerned with fitting his family's clothes into his spacious trunk than planning or providing for the five-hour trip to Cleveland. His road map showed many towns along his route that would offer all the services he needed, such as food, fuel and lodging. He didn't do any repair work on his own car since the garage was just down the street and had never changed a flat tire. He didn't even carry any tools in the car because he knew that if the car was disabled along the road he could just call back to the last garage he passed for repair service.

This morning I watched the neighbor's son load his family in the car for their three and one-half hour trip to Cleveland via the newly opened Ohio Interstate Route 71 in the same manner. Knowing that adequate services were not available, in addition to their baggage, he should have packed his tool kit and a spare fan belt, checked the tires and his gas gauge, made certain that the fire extinguisher was full and that the vehicle manual was in the glove



Typical Map Located in Motorists Service Shelter in Rest Areas—on 1R71

compartment along with the route maps and detour bulletin, and packed a basket of food to eat in one of the beautiful rest areas along the freeway.

Of the 1,400 miles of interstate highways planned for the State of Ohio, nearly 500 miles are presently open to the public, not including portions of the Ohio Turnpike. Included in the opened portions is one continuous 111-mile section between Columbus and State Route 18 south of Cleveland. All of this route is rural except for a small portion within the city of Columbus.

Travel habits have changed since the days of the first automobiles. Modern-day travelers have learned to expect adequate service facilities along their routes of travel, such as food, gas, lodging, police and fire protection, and emergency repair service. The present lack of adequate vehicular service facilities on or adjacent to the interstate system presents problems differing from those which confronted early motorists. No longer can Mr. Average Motorist perform a minor repair on the complicated motors in our cars today or even repair a tire. Many, especially women and elderly drivers, cannot change a tire. And to add to the problems confronting a stranded motorist, emergency aid is not nearby, communication facilities are nowhere to be seen, and it can be difficult to identify his location because most new rural freeways do not pass recognizable towns or landmarks.

Motorist services are generally divided into two classifications, necessary services and convenience services. Police and fire protection, ambulance service, and disabled vehicle service fall within the first category, while the second includes fuel, food, lodging and roadside rest areas. Roadside rest areas may in turn include information, toilet facilities, litter bags, picnic facilities, telephone service, as well as a place to rest. Necessary services are those usually *brought to the motorist*, whereas convenience services are generally at a fixed site and *obtained by stopping* at this location. If a motorist fails to stop for fuel (a convenience service) and runs out of gas on the freeway, he then requires disabled vehicle service (a necessary service).

The major toll roads across the country, including the Ohio Turnpike, provide both types of services on a twenty-four hour basis but the absence of some of these services on our present inter-

Typical Map Located in Motorists Service Shelter in Rest Areas—on TR71

state system has caused much concern to highway officials. This concern prompted the Ohio Department of Highways to appoint a full-time coordinator of motorists' services for the interstate highway system. Through this office, information relating to available services on or adjacent to the interstate system is being assembled and distributed to the motoring public.

NECESSARY SERVICES

Policing on Ohio's interstate highways at present is provided solely by the Ohio Highway Patrol. Paradoxically these highways which are safer than any roads previously constructed require a minimum of patrol activity, yet lack of motorist services—and safety is a service—calls for an increase in such patrol activity.

Ohio Highway Patrol vehicles contain no special equipment for patrolling the interstate system. Normal equipment includes a four-point lug wrench, a car jack, a steel tow chain and the twenty-four unit first-aid kit, in addition to two-way radio communication. At one time patrol cars carried spare cans of gasoline to assist motorists stranded with empty fuel tanks. With the advent of the two-way radio this procedure was considered hazardous, and the service was discontinued. Although this service was enjoyed by motorists it did present such problems as: should the motorist pay or not pay for the gas; should it be free; and how should the patrolman account for the gas?

Fires, although not a major problem on the interstate system, are generally serious when they occur. A majority of vehicular fires are the result of improper tire inflation or faulty wheel bearings. If fire-fighting equipment is not readily available, these difficult fires can result in serious damage to the vehicle. The local fire-protection authority in Ohio has the same responsibility for a fire on the interstate system as it does on any other road within its jurisdiction. The highway patrol is required to know the boundaries of all the political subdivisions and, upon discovery of a fire, to notify the proper authority. Fire-fighting equipment at present is permitted access at the interchanges, and since there are more fire-protection authorities than points of entry, many authorities must travel through jurisdictions of others to reach a fire on the interstate highway within their own jurisdiction. This excessive

travel time results in much delay in reaching the location where a fire has been reported. It may be possible in the future to provide necessary access points on the interstate highway, exclusively for emergency vehicles.

Ambulance service, fire service, and disabled vehicle service are now summoned by the patrol with two-way radio or by highway department employees with radio-equipped vehicles performing their normal duties. The patrol carries a list of services available in the vicinity and asks stranded motorists for their preference in the type of service desired. If the vehicle operator has no preference, such as AAA services, patrolmen choose from their list, rotating calls among those listed. This procedure is followed consistently whether the service is for fire, gas, or other emergencies. Since providing these services is a highly competitive business, this procedure minimizes complaints of favoritism from service station operators and others who might feel that they are not receiving a fair percentage of service calls. If the stranded motorist selects a particular service, the patrolman is relieved of this responsibility.

To assist the traveling public, instructions have been given to Department of Highways employees to render whatever service possible while engaged in their normal maintenance or other duties. However, the department does not provide any special equipment for these services. If additional help is needed, and if department vehicles are equipped with radio communications, assistance can be summoned through highway communication channels.

For the 1960 Fourth-of-July weekend a special force of fifty-five men was assigned to extra patrol duty from 6 p.m. July 1 to midnight of July 4. This patrol covered 259 miles of the completed interstate system and made a total of 373 service stops. These stops were for vehicles requiring gas, vehicles with tire or mechanical trouble, and other substantial reasons. Drivers sleeping or resting on the berm of the highway were merely advised to drive on to the next rest area.

Better to determine the types of service required and to estimate costs, a courtesy patrol by the Department of Highways was undertaken during the month of September 1960 over a desig-

nated portion of Interstate Route 71 between Columbus and Cleveland. This special patrol, twenty-four hours a day for thirty days, covered a selected section approximately 37 miles long in two directions—representing about one-third of the completed stretch of highway. The equipment used was a radio-equipped one-half-ton truck. Again, no special equipment was provided. Drivers covered about 222 miles on the 37-mile stretch during each eight-hour shift. During this pilot study, if immediate assistance was not possible the highway patrol was notified to follow through with major service calls. Based on the costs of this operation it was estimated that it would cost the Department of Highways approximately $107,400 to service the full 111-mile stretch for one year, an annual cost of about $960 per mile.

The results of this study indicate the type of services required. A breakdown of the service stops during the thirty-day period is as follows:

	Number	*Percent*
Driver sleeping or resting in vehicle on highway berm	247	42.9
Mechanical trouble	131	22.7
Flat tires	93	16.1
Abandoned vehicles	38	6.6
Water	32	5.6
Out of gas	21	3.6
Road obstruction removal	8	1.4
Information	4	0.7
Fire	1	0.2
Vehicle damage	1	0.2
Total	576	100.0

Of these stops the following were considered to be disablements:

	Number	*Percent*
Mechanical trouble	131	46.9
Flat tires	93	33.3
Water	32	11.5
Out of gas	21	7.5
Fire	1	0.4
Vehicle damage	1	0.4
Total	279	100.0

The largest demand for service was because of mechanical failure. It is interesting to note that service stops for motorists "out of gas" on the freeway constituted only 21 out of 279 stops or 7.5 per-

cent. On the other hand, the Ohio Turnpike with service stations approximately every 30 miles lists "out of gas" as the leading disablement, with mechanical trouble a close second. Obviously, motorists in Ohio are aware that these interstate highways offer no fuel facilities. Colorful warning signs on the approaches to the freeways such as "No gas on freeway" and "Good gosh, Gertie, get gas" have had a profound effect in reducing the number of disablements due to "out of gas."

The estimated average daily traffic over this 37-mile portion of the interstate system for the thirty-day period in September was 6,210 vehicles, or 186,300 vehicles for the month. About one motorist in every 324 required the courtesy patrol to stop in this section, and one vehicle in every 678 was considered to be disabled, and required services. During this same period assistance was rendered to 268 other motorists on other portions of the interstate system by regular forces. Although the data gathered are limited, it is apparent that a regular service patrol or a system of detecting disabled vehicles will be required. The presence, as suggested, of additional law enforcement personnel on the freeway facilities would be beneficial to traffic flow and would assure maximum protection to motorists, but this service cannot be expected completely to meet the service needs of interstate users.

Timely detection of a disabled vehicle has always been a serious problem for the stranded motorist, because a short delay often appears much longer, especially on a cold, dark and rainy night. Disabled vehicles are reported by our highway patrol, by regular Department of Highways personnel performing routine duties, and by other motorists on the highway. To supplement these services the highway department is conducting research to determine the feasibility of installing emergency call systems along highways. At present under consideration are two such systems designed to enable a driver needing emergency service to transmit a call to a central receiving agency which in turn would call the service facility desired and direct it to the correct location on the freeway. One of these devices, developed commercially, is a wireless transmitter which would be located at specified intervals along the freeway. The second system, developed by the Ohio State University's Engineering Experiment Station in conjunction with the

highway department, would require interconnection of the transmitters. Either system would permit different types of calls to be transmitted such as for police, fire, repair, gas, or ambulance, but would not provide two-way communications. Indications could be given the motorist, however, that his distress signal had been received. A system of this type could provide for all necessary services along the roadway and relieve the ever-increasing pressure on our highway patrol to provide these services. These systems are not considered the ultimate in disabled vehicle detection, and research workers in Ohio are continuing to explore new ideas to provide fast, accurately directed, responsible services for distressed motorists. Private telephones, strategically located along the highways, were considered possible but not feasible due to high installation costs, difficulty in obtaining service, and vandalism.

CONVENIENCE SERVICES

Although not at present equipped to provide adequate service patrols and necessary services on the interstate highways, the State of Ohio is foremost in providing some of the convenience services. Most obvious to the motorist on the freeways are the beautiful, spacious, well-equipped rest areas spaced along his route. At each rest area, drinking water, toilet facilities, and picnic tables are available for public use along with bulletin boards to display official road maps and other information. Telephone facilities have been installed in nine rest areas, and a program is under way to provide this service in all roadside parks on the interstate system and other limited-access routes. Illumination of parking areas and buildings in several rest areas has proven so successful that illumination is being provided at all existing and future rest areas. This illumination of parking areas and structures increased night use of the rest areas from 8 to 12 percent of roadway traffic. Due to the remoteness of many locations, difficulties were encountered in providing them with essential services. However, the benefits to the motorists more than offset any difficulties or costs for additional facilities.

As a means to provide a centralized location for display of motorist service information, a motorist service shelter was designed and constructed at all interstate rest areas. These shelters,

Roadside Rest Area on north-bound lanes of 1R71 between Columbus and Cleveland

6 feet by 12 feet, are enclosed on three sides, with the roof fabricated of translucent Fiberglas for maximum daytime illumination, and illuminated for night use.

In the motorist service shelter a strip map, displaying the interstate and parallel routes, with the location of gas, food, and lodging shown by color symbol, is prominently displayed on Plexiglas-covered bulletin boards. The center contains a public telephone, litter bags, emergency information, official highway bulletins, and other information pertaining to service facilities and points of interest.

The snow removal program on the interstate system provides for snow removal from rest area ramps, parking areas, and sidewalks in rest areas. Surveys have indicated that 10 to 12 percent of commercial vehicles and 5 to 7 percent of automobiles passing a rest area use these facilities during severe winter weather. This usage more than justifies the cost of the snow removal program.

The drinking-water facilities, toilets, and motorist service information are each housed in separate structures in the present rest areas. Future plans for new rest areas call for the incorporation of all facilities in one centrally located structure.

In addition, in rest areas near the state line we expect to provide booths to dispense travel tips, to be manned seven days a week by trained personnel who will aid the traveler by providing information on emergency services, vacation travel, or points of interest.

Since gas, food and lodging facilities are nonexistent on the interstate system, some means of directing motorists to these services on intersecting or parallel routes was needed. The immediate solution was to erect large "Gas—Food—Lodging" signs with directional arrows preceding off-ramps at interchanges to indicate the locations of such facilities within a three-mile radius of the interchange. If no such facilities are in the area, no sign was erected. In addition to these standard signs at exits where facilities are available, additional signs were erected at the end of the off-ramps indicating directions to and the location of these facilities. These signs not only aid motorists but benefit business establishments on parallel routes which have been adversely affected by the drop in tourist traffic.

Initially, a field survey of each location was required before signs could be erected. This survey included:

1. A spot map, diagram, sketch or log of the area showing locations of each service within three miles of the interchange.

2. Identification of the places which provide services twenty-four hours each day, seven days a week.

3. The capacity for service at each place of business, such as number of units in a motel or number of pumps in a service station.

4. A quality rating for each place of business and any endorsement by travel agencies.

Changes in the commercial development in areas require constant checking to insure that signs and the information disseminated are accurate. It is believed, however, that such practice provides a valuable service to motorists currently using the freeways and will continue to be important in the future as more interstate highways are completed and travel on these routes increases. As this travel increases, more services will be developed adjacent to interchanges by private enterprise. At present services are now available, are under construction, or land is under option for future development at each interchange along Interstate Route 71 from Columbus to Cleveland. Soon many services will be available at these interchanges, visible to the passing motorist.

SUMMARY

As more sections of interstate highway are completed in Ohio, changes in driver habits brought about by the absence of adequate facilities are causing great concern to public officials. With both necessary and convenience services in great demand by the motoring public, the State of Ohio recognizes its responsibility and is expediting services for interstate system motorists and their vehicles. It is hoped that future research and studies of motorists' needs in Ohio will develop new methods and equipment so we may continue adequately to serve motorists who use our present and future public highway systems.

Transportation in the United States

ERIK TENGBLAD

Mr. Tengblad has been Manager of Operations for the Stockholm Public Transit System since 1955. Previously he held other important posts in this organization where he has made his career since he was first employed in 1918. He has also served on several fact-finding commissions for the Swedish government including one on abolishing left-hand traffic. Mr. Tengblad visited this country in the summer of 1960. His observations were published in an article by the Association of Swedish Municipal Engineers, here presented in translation.

Mr. A. O. Olson, who translated Mr. Tengblad's article from the Swedish, is a special consultant with DeLeuw, Cather and Company.

A CARTOON in an American newspaper illustrates the approach to the George Washington Bridge in New York City during off-peak hours. Two toll takers have left their booths with signs "Stop—Pay Toll" and are observing a small plant growing in a crack in the pavement in the center of the lane. One exclaims, "I do believe it most nearly resembles a buttercup."

This solitary flower in the sea of concrete symbolizes our visit in the States. We saw only large cities, averaging about two and one-half days' stay in each city, without time to walk in the parks or to bathe at the beaches. It was a hectic trip, but it gave us a general impression of the varying traffic conditions in the different cities. The most beautiful city without doubt was San Francisco, but I think Cleveland was the most interesting from a traffic point of view.

Perhaps I should start by stating that I had had some previous experience as the result of a trip to the United States in 1948, and was familiar with an excellent report by a Swedish delegation which traveled in the States during 1956. Many of the conditions of 1956 still exist today, and the traffic problem is still difficult. The great sums of money required for large projects to save the cities from strangulation by automobile traffic are rarely available. There are still too many influential people who favor the automobile.

Many cities, therefore, try piecemeal solutions. They plan express bus lines—an excellent solution where the buses can move—and reserved lanes, park-and-ride areas, low-fare bus lines between

such areas and the shopping centers, to enumerate but a few examples. But when it comes to implementing plans for rapid transit or expressways exclusively for buses, we find that the planners are way ahead of the availability of funds.

PLANNING AHEAD

A transportation official in Los Angeles replied somewhat pointedly to my question of when a rapid transit plan of some sort would eventuate in this two-thirds choked city. "I am sure that it will be decided on the day when traffic stops altogether, and then it will take five years to build it," he said, and added, "You should be thankful for the foresight displayed in Stockholm on the traffic problems."

But planning is well advanced, perhaps at times a little too much like "pie in the sky," if you talk to men of the older school. Just as we arrived, San Francisco was publicizing a report calling for a rapid transit system that would cost more than a billion dollars. Los Angeles was not far behind with something similar. St. Louis had come up with an interesting plan, involving an exclusive express bus network, resembling that in Baltimore. The city of Washington is proposing a rapid transit network which would cost $265 million, and Chicago has extensive plans to extend its already considerable rapid transit system.

FINANCES AND RAPID TRANSIT

They evidently know what they want—they want rapid transit —but the Federal and State Governments are not inclined to help, and the communities lack resources. Local taxes produce but meager funds, and people are afraid to invest money in a losing enterprise. That is the way it has been for many years. It was so in 1956.

There are, however, a few exceptions. The best known is New York, where the city furnishes the capital costs for the subways. Even so, until recently it was losing $11 million a year. The Boston subway is losing $18 million a year, despite a revenue of $36 million, and is thus much worse off than Stockholm.

Nonetheless, there are active efforts toward survival. Some plans take more or less imaginative forms. To those I shall return later.

With a few exceptions, the tendency toward reduced earnings is

continuing. These exceptions are the subways, which are not so much affected by surface traffic. Many smaller cities have tried to solve the problem of reduced earnings by discontinuing service. In the last five years, 120 private companies have discontinued service. The service abandoned by these companies, in some cases, has been assumed by the affected communities, but without much enthusiasm evident.

The accelerated discontinuance of service during recent years has been caused by higher costs of labor and material, resistance to increased fares, traffic congestion, television, shutdown of business on Saturdays, and increasing living standards. Even young people find it easy nowadays to acquire many kinds of living comforts and conveniences without money; they seem to believe that they can always meet installment payments. They marry younger, buy a home with a minimal down payment, and furnish it with various kinds of modern appliances on credit, such as radio and television sets. Then they buy a new car with a low down payment, and perhaps an additional small European car. After this, little remains for other essentials and incidentals, such as transit.

RUSH HOURS

Rush-hour traffic, both hectic and costly, is growing worse and becoming increasingly a problem to transit authorities. Eighty-seven percent of the morning rush-hour traffic into Chicago arrives via mass transit facilities, 72 percent of which is subway and rail rapid transit, and the remainder buses. In Cleveland, the corresponding amount moved by rapid transit is 62 percent, and in Philadelphia 79 percent. This demonstrates the importance of mass transportation during the rush hours in the United States. With reduced off-peak scheduling, the net return from this service is poor during evenings and on Saturdays and Sundays. Against this background it is easy to sympathize with one cynical transport official who stated, "There are no problems in mass transit that a good depression wouldn't fix."

Reduction in fares does not help. During the early part of 1960 a medium-sized city tried to recapture the off-peak riders. They lowered the fare from 12½ cents to 7½ cents between 9:30 a.m. and 3:30 p.m. and after 7:00 p.m. on weekdays and all day on Sun-

days and holidays. Traffic increased by 4 percent, but revenue was reduced by 6.5 percent, and in time the experiment was discontinued.

I doubt that results would be better in Stockholm. At present transportation problems in the United States are greater than ours, but with rising living standards in Sweden we will soon catch up. Thus we may know what to expect. In Los Angeles, for example, the Saturday traffic is 65 percent, and the Sunday traffic 40 percent of the weekday traffic, and these ratios are decreasing. Evidently other cities experience even lower ratios, if one can judge by the facial expressions of some transit officials when the subject of weekend traffic is discussed. Thus, Cleveland's Saturday traffic is but 50 percent and the Sunday traffic 20 percent of the average weekday traffic.

BUSES PREDOMINANT

The streetcar is no longer important as a means of surface transport, and trolley coaches are also on the way out. Diesel buses and, in some localities, propane buses, have taken over. No streetcars have been built since 1953, and only some fifty trolley coaches have been produced since then in the United States. The greater flexibility of buses is the reason; they move more smoothly in modern traffic. It is forecast that in another ten years streetcars will disappear in the United States.

Practically all vehicles have been converted to one-man operation. Two men on a bus would be economically prohibitive, even if manpower were available. Fare collection in the United States takes about the same time as it does in Stockholm, as far as I could observe. Although in most localities a single fare was collected on entry, considerable time was required to make change. In some cities a zone fare is used, the collection of which is also time-consuming.

The new buses are easily maneuvered in traffic, are luxurious, and have good visibility through recessed front windows. Pneumatic shock absorbers are now standard. In many cities where summer temperatures require it, buses are air-conditioned at a cost of approximately $5,000 each, but this cost is considered justifiable. It promotes the use of buses and creates a feeling of comfort and well being. Much discussion was heard about air conditioning, and in some cities a higher fare was charged on buses so equipped. It could

be worth it, to arrive at one's destination feeling cool and refreshed.

In many cities, especially in New York, it is claimed that the new, more elaborate buses have encouraged riding. The manager in Pittsburgh declared regretfully that he was aware of the advantage, but for a long time past had been unable to afford a new bus.

Exclusive bus lanes are becoming increasingly common. More and more cities are establishing such lanes in combination with one-way street arrangements and no-stop regulations during rush hours. Baltimore, foremost in this, has fifteen streets with special bus lanes, one of which is eighteen blocks long. The special requirement for establishment of exclusive bus lanes is that the street must normally be one-way and have three lanes, in order to keep one for buses. In addition, buses are required to carry one-third of the street's passenger volume, a condition which seems reasonable. Other cities have rules requiring not less than one bus per minute on a street to justify an exclusive bus lane.

The bus lane is usually located nearest the sidewalk and is reserved for buses during rush hours, when "no stopping" regulations are imposed on the other traffic on the street. In some places, on wide streets, the exclusive lane is located adjacent to the center island, where buses are permitted to pull out for special loading zones. This is the arrangement in Chicago on five-lane, one-way Washington Street for a stretch of over one-half mile, where the frequency is between 90 and 120 buses per hour. All of the buses on this street cannot be accommodated in an exclusive lane; some continue slowly to fight their way crowded in the general traffic. Traffic moves slowly even in the special lane. Street crossings especially cause delay. Nonetheless, bus travel is faster and more dependable in rush hours. The advantage is 15 percent during peak hours and 30 percent in off-peak hours.

Cleveland, too, has made many innovations. Euclid Street, a long principal thoroughfare, is devoted almost exclusively to buses. Parking and turns are prohibited. Traffic density exceeds 120 buses per hour. Private cars appear to shy away from this street, a good arrangement, inasmuch as there are excellent parallel streets. The parking meters formerly along Euclid Street have been removed in spite of objections from the merchants. Now they do not want them

back; they like the pedestrians who use the buses in large numbers for shopping purposes.

Park-and-ride is becoming more and more popular. New large parking lots are being built near railroad, subway, and streetcar lines. Where there are no rapid transit facilities, parking lots and low-fare bus lines to the downtown section are appearing. Compared to the parking rate downtown, such park-and-ride arrangements offer a definite advantage in lower over-all cost, particularly in Cleveland, where parking is free. Much effort is being devoted to making park-and-ride lots convenient and attractive, with short walking distances to trains. Likewise, short-time parking "kiss-and-ride" lots are provided for commuter wives waiting for their husbands.

PARKING AND TRANSFERS

On the other hand, there is skepticism about the desirability of locating large parking establishments in the downtown area. It is claimed that such facilities create traffic problems during the rush hours. Again I refer to Cleveland, where authorities contend that it is better to provide the parking facilities outside the downtown area. Here they believe that, while improved parking arrangements would increase the economic well-being of the commercial establishments in the downtown area, nonetheless this is not the solution to the entire problem. Even without the best parking facilities in the downtown area, stores can count on a great number of customers from rapid transit patrons and from commuters employed in the city.

Cleveland undertook a special suburban parking project in 1958. It involves building a large parking lot for which the adjacent commercial property owners are required to underwrite two-thirds of the cost. Finished lots are rented to neighborhood merchants who pay the cost from operating revenues. Five lots are now in operation and ten more under construction. A 10-cent parking fee is collected at automatic exit gates. The merchants buy tokens for 8 cents which they distribute to their customers. The plan has been very successful and profitable. Here, it is claimed, the authorities have discovered a means to help the one who helps himself. They have shown the merchants where the straps to their boots are.

But such schemes are possible only if the facilities are convenient to the shopping centers. Otherwise, deterioration of the shopping area will continue. The enterprising transit management in Cleveland fortunately organized a good surface transit system and a well-managed rail rapid transit, with excellent transfer stations and parking arrangements.

Here we find an example of the irrational in American community affairs. An extension of the subway, with a connection through the downtown center, was recently vetoed by the responsible authority. In Stockholm, such a proposal would undoubtedly have been heartily endorsed. This proposal would have given Cleveland three important downtown stations and provided four times as many people with less than a 1,000-foot walk to the nearest subway station. Transit officials say pessimistically that it will be a long time before this proposal can be made again, although the present transit system up to now is admittedly successful. Last year they began operation of a new terminal station, and the 1,500 parking stalls provided were fully utilized the first day of operation, so that 500 additional stalls had to be provided.

Some people question the practicability of transfer from bus to subway. They question its acceptability by the patron who, they say, will not transfer from bus to train, but will rather continue to drive. For this reason in St. Louis and elsewhere, they are toying with the plan of building rapid transit type expressways for buses. Buses could thus leave the expressways in the suburbs and distribute the passengers more conveniently in the less densely populated areas. The conclusion drawn from experience in many cases is that transfer stations must be as convenient as possible.

One cannot economize here. The walkways must be direct, grade separated, and free from crosscurrents, with escalators, moving sidewalks, and no fare collection or transfers. Preference is for few feeder lines. It is better to invest large sums in park-and-ride arrangements. It is cheaper for patrons to drive their cars to the station than to operate feeder lines in the sparsely populated suburbs. Cheapest of all are "kiss-and-ride" arrangements, which I personally recommend.

A good example of a well-planned transfer station exists in Toronto in Canada. Their Eglinton station has ten bus and trolley

coach feeder lines, with a maximum of 200 buses per hour. Passengers arrive on the subway train, take an escalator to a sub-surface walkway that is neat, well lighted, and has fine business concessions. From there they walk through one of ten stairways to their specific bus line. The arrangement is working excellently, but the station is becoming crowded. They now regret that they did not make it about 50 percent larger. They should also have provided escalators instead of stairways to the buses.

THE BUS STATION IN NEW YORK CITY

The New York Port Authority (which treated us to an exciting helicopter ride over New York City) has built on Manhattan the world's largest bus station at a cost of $25 million. Today it would cost much more. It occupies a square block and serves 230,000 bus riders each day, most of whom commute to and from New Jersey on the other side of the Hudson River. The station is a four-story structure with escalators between floors, and parking lots for 450 cars on the roof. Long-distance runs are served from the bottom floor. (We traveled there by bus from Philadelphia.) The middle floor houses ticket lobby, waiting rooms, baggage room, and a large number of business concessions. Local buses are served from the upper floor. Twenty-five hundred buses are dispatched from this station daily; they move on special ramps to the Lincoln Tunnel without contact with the surface streets.

Sixty percent of the operating expense of this station is defrayed by profits from the concessions and 40 percent by charges to the bus line operators. The drug store in the station, for example, has an annual revenue of $2 million, of which 10 percent is paid to the administration. They are considering adding a floor to this station and are building a similar station adjacent to the George Washington Bridge.

VARIED NEW SOLUTIONS

The ability of the Americans to adopt new and untried solutions to their problems is documented in many ways, especially when the requirement is to keep streets clear and traffic moving. I was particularly impressed by the speed with which two cars were dispatched to haul away illegal parkers in tow-away zones.

Innovations in Chicago: I observed much that was new and interesting in the transit picture. Here I can mention but a few examples. The Chicago subway has radio communication between trains and the dispatch center through the third rail, a system highly satisfactory to the city. This is of great interest to us because in Stockholm we are now trying a similar arrangement. There they are also experimenting with a scheme whereby contact would be established between each bus and the dispatcher at stated points along the route to establish the degree of adherence to schedule. They are experimenting with a method to establish the number of passengers at each stop. They are trying out a means to determine the number of passengers riding in the buses between stops by recording footsteps electrically. A new and improved exit-door mechanism on a one-man bus, which gives greater safety and easier maneuverability, should be tried in Stockholm. Lastly, I should mention that some localities have established the practice of mailing timetables to riders who request them, and thereafter mailing revisions as made.

The Monorail and Speedwalk: We looked at the Alweg monorail when we visited Disneyland in the Los Angeles area, but it failed to impress us as the transit of the future. It was perhaps too much to expect of it, since Disneyland is an amusement park. We were willing to accept the statement of the chief engineer who said, "As traffic experts, engineers and planners, you may not like our monorail, and you can undoubtedly point out the system's weaknesses. But you can't convince us that it lacks in public appeal—not that it is unacceptable in principle." It is quite evident that the installation has been a public attraction in Disneyland. About two million people have taken rides on it and the "speedwalk," the moving sidewalk leading into the train platform, which seemed to be unusually effective and safe. No mishaps have ever occurred on it. A similar sidewalk was removed earlier in Chicago because of accidents that occurred where the moving walk connected with the fixed walkway. There they are now planning to install a later model that "will not permit even a handkerchief to get caught." Great interest in moving sidewalks is displayed in America. According to the manufacturer, they cost 20 percent less than escalators.

Much more could be said about transit in the United States. Only a cross section of the problem is mentioned here; many other

impressions could be recounted, but space will not permit. What remains is to sum up the planning for the future, which I found very interesting.

TRANSIT PLANS FOR THE FUTURE

A branch of the subway was built in the center mall of a large expressway in Chicago, the Congress Expressway. There are five lanes for automobile traffic on each side of the mall. Access to the stations is provided by long ramps from the bridges over the expressway. The present intention is to extend the network of this kind of transit in Chicago rapidly, and the Chicago Transit Authority is ready to invest $400 million for modernization and extension of the subway. Here Federal funds are helping with express highway construction. In the meantime, the Transit Authority has built four high-speed prototype cars, with a top speed of over 68 miles per hour, and it is said that, "These cars are the first high-speed cars designed and built especially to meet the drastic change in the mass transit industry taking place in the Atomic Age." A newspaper account stated that the city fathers were actually frightened by the high speed demonstrated when they accompanied the experts on a trial run of these cars.

The authorities are aiming even higher in San Francisco, where a few years ago they removed the rapid transit tracks from the San Francisco-Oakland Bay Bridge and paved the space to make more room for automobiles. The recently prepared plan for a rapid transit system for the San Francisco Bay area, consisting of San Francisco and four other counties, has as its goal a project which will surpass all other transit systems in the world. They estimate that, with its tunnel under San Francisco Bay, it will cost over a billion dollars. Trains are planned to run at seventy-five to eighty miles per hour, with a scheduled speed of forty-four miles per hour, twice the speed of subway trains in Stockholm. A dozen car manufacturers are trying to determine the type of car, to be decided on in 1961. The project is based on a conventional double-track system, supported on longitudinal concrete beams. However, all systems are being considered. Operation of the trains, consisting of ten cars, will be wholly automatic and will be controlled by an electronic computer. Only one man will be on board. This system will accommodate 30,000

passengers per hour in each direction, with seats for all. This is equivalent to the capacity of a ten-lane expressway. Thus the plan, but whence the money?

I met a great deal of skepticism with regard to the ability both to create such a system and to secure money from the voters in the Bay area, all of whom are car owners. The two-thirds majority required is not easy to get.

Los Angeles must build some thirty miles of six-lane freeway each year in order to accommodate the steadily increasing number of automobiles. Against this background, they have proposed a new rapid transit with about the same performance requirements as planned in San Francisco, but at half the cost. Here they are planning to use equipment similar to the rubber-tired trams of the Paris Metro. The city is so extensive that not more than 30 percent of the area can be served by rapid transit. The plan in addition includes a conveyor car system in the downtown business area to move small cars accommodating eight passengers. These cars move fifteen miles per hour but slow down at the rapid transit stations to take on and deliver passengers by means of slower moving parallel belts.

Lastly, I wish to say something about St. Louis which, like Baltimore, is moving in another direction. The city is so scattered that it is thought than an ordinary subway would influence too small an area and be too expensive. They have, therefore, produced an interesting rapid transit plan for using buses on elevated structures. The construction cost is low and the plan would require no feeder lines, since 80 percent of the trips downtown would be direct. Passengers would be distributed downtown over a grade-separated bus loop about one and one-quarter miles long. It is estimated that approximately 550 buses per hour would circle this one-directional loop, and then continue on their own radial expressway. The system is estimated to cost $340 million, exclusive of buses already in service. The method of financing proposed for this project is interesting. It involves imposing a use-tax on every automobile within the St. Louis territory, sufficient to raise $20 million a year to service the bond issue. The plan proposes that bus lines be no more than one-quarter mile from any residential district, and that all-day parking be discouraged within the downtown area by imposition of high parking fees. The difficulty in effectuating this plan lies mainly in

the fact that St. Louis, unlike many other cities, has so far been unable to create a regional transit authority.

THE AUTOMOBILE VERSUS PUBLIC TRANSIT

In summation, it must be stated that the automobile still is king in America. Encouraged by the Federal $40-billion, 42,000-mile expressway program, freeways, expressways, and superhighways are being built through the cities. This program includes 5,000 miles of limited-access freeways within cities. Cities are beginning to realize that money must also be spent on public transit in order to save their downtown areas from death by strangulation.

It is difficult to get all automobile owners to change from talk to action, but the horizon is brightening. The previous administration, which had not at first encouraged cities in their efforts to obtain Federal aid for mass transport problems, later favored legislation to enable the cities to include mass transit in freeway plans. Two advantages would be realized. First, it would make funds available for mass transit, and second, it would shock private car owners into transferring to mass transit facilities. Los Angeles authorities are trying to obtain gas tax money to help finance rapid transit. The manager of the American Automobile Association believes that this may be possible, because "every driver considers rapid transit necessary, so that the driver in front of him and the driver in back of him may disappear."

Finally, what is the answer to future mass transit in America? It is not easy to foresee. As for me, I believe that the smaller cities, with more space than the large metropolis, must continue with their present difficulties. Their economic help must be obtained locally, which will be difficult. In the large cities, the importance of mass transit is being recognized. Such mass transit must be of very high standard if it is to compete with the private automobile. Tremendous expenditures are involved and, for this reason, time is needed to change public opinion. It is going to be interesting to see if the large transit projects will actually be built or stay on paper. Much depends upon whether the Government shows sufficient interest to help out.

Lincoln Road Mall, Miami Beach

MORRIS N. LIPP

Mr. Lipp, now City Manager of Miami Beach, was Assistant City Manager from 1952 to 1958. He also serves as City Engineer along with his city managerial duties. As City Engineer, he is credited with the solution of several unique problems including beach erosion and sewage disposal. Altogether Mr. Lipp has been directly responsible for $40 million in civic improvements in Miami Beach, the most recent being construction of the $600,000 Lincoln Road Mall he writes about in this article. He is a member of the Florida and Federal Bar Associations, the Florida Engineering Society, the American Society of Civil Engineers, and the American Shore and Beach Preservation Association and has written several treatises on engineering subjects.

MIAMI BEACH, as a resort city, has since its birth been aware that no section of the city must be allowed to become dowdy or suffer from urban blight.

To citizens, property owners, and visitors, a fresh charm and beauty throughout the community has a high dollar-and-cent value. Tourism is a major industry in Miami Beach. Visitors are not apt to be drawn to a shabby city when they are looking for the kind of vacations the Florida Gold Coast offers. Keen awareness of this premise led Miami Beach to pioneer in the type of civic improvement exemplified by the new Lincoln Road Mall.

Lincoln Road has been an attractive thoroughfare, but, as Miami Beach spread northward during the last decade, the threat arose that the pendulum of popularity might swing too heavily northward with the expansion of hotels and resort facilities in that direction. Lincoln Road property owners and Miami Beach civic officials and voters, while welcoming the new, were strongly aware that the older part of the city might suffer by comparison.

HISTORY OF LINCOLN ROAD

A thrifty sense of the economic value of novel and dramatic beauty sparked the conversion of this cosmopolitan avenue into one of the nation's first shopping malls. This conversion was made with the same spirit attending the creation of Lincoln Road itself.

In 1912, a wooden causeway was built from the mainland to

the beach-fringed mangrove swamp between Biscayne Bay and the Atlantic Ocean—the island which was to become Miami Beach. In the same year, the creator of Lincoln Road, Carl Graham Fisher, arrived and, captivated by the climate, bought a large acreage of swamp. One of his first acts was to clear the swamp and pump in bay-bottom fill, then to have a wide strip hacked through the mangrove trees from Biscayne Bay to the ocean side of the island. This "main street" he named Lincoln Road.

James Whitcomb Riley planted an Indian laurel tree in the parkway on Lincoln Road and James Avenue on April 12, 1915, and read verses he had written commemorating the building of the national Lincoln Highway, a Fisher-promoted enterprise. He pointed out that the new avenue was named for the American President Fisher so admired.

The first building to be erected on Lincoln Road, in 1915, was Fisher's ocean-front residence. An office building, a hotel, a church, a bank, and commercial buildings followed. The Lincoln Road Association composed of property owners along the avenue was formed in the 1920s.

Lincoln Road, which lies between Sixteenth and Seventeenth streets, has a right-of-way width of 100 feet and extends from the Atlantic Ocean on the east to Biscayne Bay on the west, a distance of 5,200 feet. Over the years, it has been the major shopping street of Miami Beach.

By the end of the thirties, Lincoln Road was becoming known as the "Fifth Avenue of the South." Its popularity led city officials to pioneer in off-street parking facilities. First of the city's off-street parking lots was built on Lincoln Lane, one block north of Lincoln Road.

At one time a private eighteen-hole golf course bordered the north side of Lincoln Road; this golf course area was purchased by the city in 1929. The city acquired land for a new municipal golf course by dredging a bay-bottom tract in the northerly part of the community in 1938. In 1943 the privately owned Bayshore Golf Course was bought by the city and subdivided for residential purposes.

These measures were key factors in the rejuvenation of the Lincoln Road area.

One Block of the Eight-Block Lincoln Road Mall

Lincoln Road—Before and After

On the old golf course property a municipal auditorium was built in 1950, and a convention hall in 1958. Farther to the north, a new high school was built in 1960, and a garden center is to be constructed here this year.

The Lincoln Lane parking area was double-decked in 1958 through the issuance of parking revenue bonds which proved highly successful. Today, this municipal parking area has space for 2,000 cars, with 611 meters on the elevated deck. To the west of the convention hall is a non-metered area for 600 cars.

Construction of the auditorium and the convention hall so near to Lincoln Road was an economic stimulus to the merchants along that avenue. But they dreamed of something to bring the non-convention visitors who fill the hotels far northward up the Beach down to Lincoln Road to do some of their shopping while on vacation.

The Mall was the answer, but it was years before it became a reality, as is often the case with daring projects. The Lincoln Road Progress Association, a group of Lincoln Road property owners and retailers, spearheaded the project. In 1957, the Lincoln Road Association engaged architect Morris Lapidus to prepare drawings showing his conception of a pedestrian shopping mall. Lapidus is a pioneer and an apostle of the glamorized shopping center as the modern version of the ancient market place.

DETERMINING FEASIBILITY

During the winter and spring of 1959, especially in February when the population of Miami Beach is at its annual peak, extensive traffic studies were made by the city engineering department with particular attention to bus routes and loading points. The results of these studies led to many important traffic changes. In all there are 2,900 off-street metered parking places within two blocks of the Mall.

Consideration was given to making Seventeenth Street one way going west and Sixteenth Street one way going east. However, if this were done shoppers approaching Lincoln Road from the north and west would have to take a circuitous route to enter the major parking areas and many would be discouraged from using Lincoln Road for shopping, thus defeating the purpose of the Mall.

The traffic survey showed that with its completion the Mall could be expected to attract shoppers from the mainland over the two nearest causeways, because of the smoothness of the traffic flow in the area and the ease of parking.

The area between Alton Road and Washington Avenue, 3,000 feet long, consists of eight city blocks; the final decision was for this to be the length of the Mall.

FINANCING

The Lincoln Road Mall Association made a survey of the affected property owners and found them generally agreeable to construction of the pedestrian mall and to paying for the cost on an assessable basis.

The city charter was amended on June 2, 1959, in a general city election, to permit construction of malls on city streets and to make such construction assessable, as in the case of sidewalks, against abutting properties. The charter was amended by a vote of the people of the city in accordance with the provisions of the metropolitan charter of Dade County. This charter, recently authorized by the Constitution of the State of Florida, supersedes the authority of the State Legislature to amend charters in this county.

Power to fully assess such a project against the abutting property owners was tested in the courts and approved.

Subsequent to the amendment of the charter, a freeholder election was scheduled for November 3, 1959 to authorize the sale of general obligation bonds in the amount of $600,000 to raise funds for construction of the Mall.

One requirement of the Constitution of the State of Florida is that to authorize the issuance of general obligation bonds more than 50 percent of the registered freeholders must participate in an election. In this election, 55.8 percent of the registered freeholders participated and 76.6 percent of those who voted favored issuance of the bonds.

Bonds were sold July 20, and work began immediately, although the official groundbreaking ceremony was not held until August 1, 1960. Construction costs will be assessed to fifty-nine property owners of sixty-five parcels of land along Lincoln Road,

who over a ten-year period will pay the cost plus interest on the unpaid balance.

CONSTRUCTION

The deadline for completion was set for Thanksgiving Day. Because Miami Beach is primarily a winter tourist resort, it was essential that the work be completed as scheduled, although but few detailed plans were available when the bonds were sold.

Beginning with the depression years, the city of Miami Beach has done most construction with its own forces, particularly paving, sidewalks, sewers, water mains, and landscaping. The city forces immediately started removing trees, laying underground structures consisting of storm sewers, water mains, and electric conduits.

The work was so varied that no one contractor could handle the entire project. Nor did time permit the breakdown and receipt of bids on the various structures and walks.

In addition to the city forces, approximately twenty-five contractors were engaged to perform the labor work under a cost-plus arrangement in accordance with their various specialties, the city to furnish the material. Contractors were soon spread out over the entire work, and the project was completed on schedule, despite Hurricane Donna. The city maintained the role of prime contractor and co-ordinated all phases of construction through its engineering department.

All north-south thoroughfares continue to pass through the Mall. This has proved to be a wise decision. It has had little effect on pedestrian movement, since traffic signals on the secondary streets are timed to favor the pedestrian.

The original steet lighting consisted of ornamental standards and bracket arms supporting lumenaires with 10,000 lumen incandescent lamps each. These poles were spaced in a staggered manner along the curb on each side of the road, approximately 150 feet apart.

The new system consists of color-corrected mercury spot lights on tall galvanized poles located along the center line of the Mall. All are fitted with honeycomb-type grills to prevent glare. Total wattage for street illumination is 50,000.

The architect's concept of the Mall made landscaping a major feature of the entire project. All landscaped areas were developed by the city park department.

The variety in shape, color and texture of landscaping materials used and the artistry of their placement has caused the Mall to be described as "a work of art on an eight-block long canvas."

The landscape plantings on Lincoln Road Mall are a homogeneous blending of tropical and subtropical trees, shrubs, and ground-cover plants, so arranged as to provide both usefulness and beauty to the area. The many graceful, towering palm trees provide shade and a tropical atmosphere.

The landscaping of the Mall is planned not to become static, but rather to be an ever-changing scene which will attract repeated public attendance.

Shelters and fountains with flowing jets of water are spaced the length of the Mall, and each block has an individual character. There is at least one shelter to a block, with no two identical. Some are provided with removable glass enclosures. Near the center of the Mall is a sheltered area for concerts and other group entertainment.

The Lincoln Road Mall Association was designated by the City Council as the advisory board in connection with the control of displays and other activities in the Mall.

TRANSPORTATION

Nine-passenger electrically operated trams are provided for transporting people up and down the Mall. These colorful trams, with fringed surrey tops, travel along the outer edge of the border walk and operate at frequent intervals between 9 a.m. and 11 p.m. At present ten are in operation. The fare for a one-way trip is 10 cents.

THE FUTURE

It is anticipated that the outstanding bonds can be redeemed within the next eight years.

Despite the novelty and attractiveness of the Mall, it is realized that it must be properly utilized in order to continue successfully. To this end, a carefully planned schedule of seasonal and special

events is being designed to keep Lincoln Road and its retail establishments continually before the public. These events will be coupled with continuous publicity, advertising and promotion by the Lincoln Road Mall Association and the merchants on the Mall.

Occupancy of all municipally owned parking areas in the vicinity has increased considerably since the opening of the Mall. By the nationally accepted standard of 85 percent as the maximum usage in metered parking areas, surveys for a comparable eight-week period during 1960 and 1961 indicate a 26 percent decrease in the number of available spaces in the largest parking areas serving the Mall.

The Mall as a whole has attracted more pedestrians and visitors throughout its entire length. Concrete evidence is disclosed in a comparison of pedestrian counts on Lincoln Road last year and on the Mall this year.

On February 17, 1960, during the peak population period, pedestrians at Meridian Avenue and Lincoln Road, the center of the strip, totaled 10,410 between 7 a.m. and 7 p.m. On April 3, 1961, a pedestrian count at this same intersection and for the same period totaled 15,593 persons. Although the actual dates are not the same, experience over the years based on special economic factors has shown them to be comparable.

This 50-percent increase in pedestrian traffic warrants the assumption that one of every three persons was attracted by the development of the Mall. It has without doubt met their expectations.

Finally, and most important to them, the business of the merchants on Lincoln Road has improved since the Mall opened.

General Traffic Plan for the City of Basel, Switzerland

PROFESSOR DR. ING. K. LEIBBRAND

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IN 1955, the Canton of Basel City ordered the study of a general traffic plan. The work was completed in 1958. The essential considerations upon which the plan was based follow:

1. To free the central districts from all private traffic foreign to them by the creation of tangent thoroughfares and extensive parking lots.

2. To free the central districts from surface public transport by placing some sections of the tramway routes underground.

3. To link the City of Basel with the superhighway.

BASIC CONSIDERATIONS

Town Planning. In its transportation system, the City of Basel enjoys a special geographical position in the center of Europe. The history of the 2,000-year-old city shows the favorable influence of traffic upon its development and prosperity. Although the influence of its geographical position may be considered favorable, the topographical conditions of its urban zone are not favorable to traffic. Consequently, improvement of traffic conditions is considerably more difficult here than in many other Swiss or foreign cities.

First of all, basic questions of principle must be decided. Is traffic to explode the structure of the old city? Is traffic to be choked to suffocation in the present narrow streets, or can a balance be found between the structure of the city and its urban traffic?

In Basel, the business district and the old city are one and the same. If additional space is to be provided for traffic, the historic monuments which now characterize the city must disappear. Some modern architects condemn maintenance of the old city. With a modern approach to town planning, necessary space for present and future traffic could be provided.

But one may ask how long it would require completely to reorganize and rebuild the city. In cities destroyed in the war, indispensable changes were possible only over the course of many years, and nowhere was reconstruction undertaken on so vast a scale.

Perhaps it might be more reasonable to begin by building a new city on virgin soil adapted to the requirements of traffic. Such theoretical consideration overlooks the fact that the position of a city such as Basel is dictated by the nature and the geography of its transport; this position is to be found nowhere else within the city area or its environs.

An opposite concept is based on the principle of placing large-scale restrictions on traffic, the old cities thus to be reserved for pedestrians. But extensive restrictions on the movement of traffic inevitably result in the development of slums, which cannot be the ultimate objective. It should be emphasized, moreover, that the consequences of restrictions on commerce and trade are often more serious than those on passenger traffic.

A sound balance between conflicting requirements within the framework of modern city planning is the only solution capable of serving the best interests of the city as a whole. A solution must be found which takes into equal account both the need to respect the city's heritage and the needs of those who earn a living in this city and are consequently dependent on traffic.

The time limit to complete the plan has been set for the year 1980.

TABLE I—POPULATION BY ZONE

	1954	*1980*	
Zone		*Maximum Probable*	*Minimum Probable*
Entire Basel Traffic Area	333,603	400,000	364,500
Cantons of Basel City and Basel-land	274,878	326,000	296,000
City of Basel alone	192,750	212,000	212,000

Increasing Importance of Traffic. The reduction in the size of families due to a drop in the birth rate, and the increased average age of the population result directly in increased demand for transport, although the total population remains constant.

The movement of the residential population outward from the center of the city toward the periphery and neighboring towns entails extension of the traffic network, and increases transport requirements. In years to come, the five-day week will become general throughout the city, a factor which may cause a fall of 3 to 4 percent in traffic.

To this increased traffic should be added the special factors leading to unequal development of private traffic over public trans-

TABLE II—ACTIVE POPULATION COMPARED WITH TOTAL RESIDENT POPULATION

		Active Population: Persons Traveling from Residence to Place of Work and Return	
Year	*Resident Population*	*Number*	*Percent of Resident Population*
1939	161,610	73,272	45.5
1955	194,720	108,800	55.9
Increase	20.5%	48%	

TABLE III—TRAFFIC PER INHABITANT, SWISS FEDERAL RAILWAYS AND BASEL PUBLIC TRANSIT SYSTEM (IN MILLION PASSENGERS)

Year	*Swiss Federal Railways*	*Basel Public Transit System*
1938	113.3	37.3
1957	221.4	84.6
Increase	95%	127%

TABLE IV—FACTORS DETERMINING AN INCREASE IN TRAFFIC

Factor	*Maximum Probable*	*Minimum Probable*
Population and Change in the Social Structure	1.45	1.30
Extension of the City	1.10	1.05
Economic Situation	1.00	0.90
Length of the Working Day	0.97	0.96
Total (product of the factors)	1.55	1.18

Note: This chart shows how the amount of traffic, i.e., passenger miles, is affected by various factors. For example, a 1% increase in population will result in a 1.45% increase in traffic; a 1% increase in size of city will mean 1.10% increase in traffic.

port which is likely to decline. With growing motor traffic, seasonal variations in public transport in winter and in summer will be intensified. This will entail considerable expense for the city in providing a street network adapted to peak summer and winter traffic.

By 1980, the percentage of motor vehicles carrying passengers will rise from 57 to 60 percent or more over 1957. The average load on the street surface will be multiplied, at the probable maximum, by 3.2 percent for private vehicle traffic and by 2.8 percent for general traffic.

TABLE V—EVOLUTION OF PRIVATE MEANS OF TRANSPORT IN THE CITY

Year	*Bicycles*	*Motor-cycles*	*Cars*	*Taxis*	*Trucks*	*Motor Vehicles (Total)*	*Annual Percent Change*
1910	11,500	110				190	
1920	16,850	360	700	30	175	905	+38.0
1930	31,650	1,340	3,240	115	700	4,055	+35.0
1938	52,400	1,080	4,560	65	915	5,540	+ 4.5
1940	58,200	240	2,760	65	700	3,525	—18.0
1946	62,100	920	3,650	65	1,340	5,055	+ 7.0
1950	75,400	3,520	7,850	75	1,780	9,705	+23.0
1955	76,000	10,080	13,970	75	2,160	16,105	+13.0
1957	73,000	11,100	17,200		2,630	19,900	+11.0
1980:							
Minimum probable	75,000	14,000	26,000	170	3,100	29,000	+ 3.2
Maximum probable	75,000	21,000	38,000	250	4,600	43,000	+ 6.7

Traffic Counts. Special, carefully interpreted traffic counts made it possible exactly to determine the traffic movements. The heaviest currents of traffic served by the Basel Public Transit System which are most sensitive to the time factor are of major interest for traffic planning. There are heavy concentrations of traffic in important sectors of the city and on the bridges over the Rhine. Congestion in this part of the city already causes cars to bypass it when possible.

Future requirements for parking space were determined by three methods: by the number of vehicles registered, by traffic counts, and by the active resident population.

Town Planning. Obviously, nonessential traffic should be eliminated. The objective should be to shorten the distance between

place of residence and place of work enough so it can be covered by foot. This simple principle can be put into effect only gradually because of the housing shortage.

GENERAL CONSIDERATIONS

The center of gravity of the business life is the heart of the city, and town planning must follow closely the repercussions of business affecting traffic. In all new buildings, a sufficient number of garages and parking lots must be provided. The concentration of tall buildings is a factor favoring efficient operation of public transport services, but construction of skyscrapers should be permitted only on condition that the total number of square feet provided is not greater than that of the present built-up area.

Costs. Improvement of a street network is expensive. The general influence of costs is unquestionable, but the degree of importance is difficult to determine. The establishment of costs for streets is one of the most controversial aspects of the economics of transportation. It is difficult to make improvements in public transportation on a scale bold enough to meet requirements and provide a profitable investment in the long run.

TABLE VI—TOTAL TRAFFIC IN THE URBAN ZONE

(IN MILLIONS OF PASSENGER-KILOMETERS, IN MILLIONS OF VEHICLE-KILOMETERS FOR TRUCKS)

		Public Traffic		*Private Traffic*				
Year	*Inhabitants*	*BVB*	*Taxis*	*Cars*	*Motorcycles*	*Bicycles*	*Trucks*	*Total Passenger Traffic*
1920	135,430	64	0.8	3.4	0.8	8	0.9	77
1930	147,220	89	4.3	20.8	3.7	16	4.9	134
1940	161,470	82	3.2	22.1	0.8	32	5.6	140
1950	182,520	178	4.7	75.5	13.5	45	17.8	317
1955	194,860	211	4.9	144.	40.0	46	23.8	446
1980:								
Minimum probable	212,000	250	12.8	312	61.6	45	40.0	681
Maximum probable	212,000	327	18.8	462	92.3	45	60.0	945

Hours of Work. It is not sound economics to deal with the transport system as a whole in terms of short, disproportionately heavy peaks. These peaks can be diminished significantly by staggering working hours and adopting the continuous working day, and it is

to be hoped that both measures will be introduced on the widest possible scale. But since any change in the hours of work would result in a profound change in the habits and family life of the individual, generally speaking, the proposal has little likelihood of being well received by the population.

A radical change in the pattern of traffic or general adoption of the continuous working day are not factors on which to count with certainty during the period covered by the plan.

COMPOSITION OF THE TRANSPORTATION NETWORK

Public Traffic. Because the older facilities for transport into the city are reaching their limit, Blotzheim airfield should be adapted for the development of air transport. During the last few years, the Rhine has regularly carried more than 40 percent of the nation's import and export traffic. The docks at the port of Basel are now nearing the limit of their capacity, and traffic is extending toward the river ports in the territory of the Canton of Basel. Rhine navigation authorities are of the opinion that it is no longer possible to rely on further extension of the port. Nor can any fundamental change be expected in the railway network.

Short distance public transport includes the subway and suburban railway, tram, bus, trolleybus, and gyrobus. Taxis which also enter the picture require no special installations beyond the usual stands. The area of Basel City which its transport services must serve is extensive, but nowhere is there a sufficiently heavily populated, continuous zone to justify construction of a subway from an economic point of view.

Tramway tracks can be laid in the public road or in their own right-of-way. In a number of cities, some sections of the tramway route have been put underground.

The category "bus" includes trolleybus, motorbus, and gyrobus. Because in transportation planning the difference between these vehicles is small from the technical point of view, plans can be drawn for buses, the cost of operation determining in each case the type of vehicle to be adopted.

Basel Public Transit System (BVB). The gross value of the Basel Public Transit System is estimated at $6 million. The value of the equipment may be estimated at from one and one-half to twice this

figure. The major part of these capital investments would be lost if the changes are not effected at the time they are totally amortized.

Variation 1. The BVB customarily calculates the amortization rate at 3 percent applied to three-fifths of the cost price. In this hypothesis, the annual expenditure is as follows:

Tramways	1,614,980 francs ($371,445)[1]
Motorbuses	2,056,950 francs ($473,098)
Difference: debit for motorbuses	441,970 francs ($101,653)

Variation 2. Amortizations affect the total value, giving as a result:

Tramways	1,594,980 francs ($366,845)
Motorbuses	2,125,380 francs ($488,837)
Difference : debit for motorbuses	530,300 francs ($121,969)

Variation 3. With no change in the cost of new vehicles, a constant average yearly value would be obtained for the depreciation estimates, and an amortization rate of 3.7 percent of capital invested for the motortrams could be applied, 4 percent for the tramway trailers and 6 percent for the motorbuses. The annual charges are therefore:

Tramways	1,596,090 francs ($367,090)
Motorbuses	1,963,090 francs ($451,510)
Difference: debit for motorbuses	366,260 francs ($ 84,240)

The changes called for by the plan would lead to taking account of depreciation values of some 2 million francs. Using Route 3 as a test case, the calculations are fully accurate, and the conclusion is that the routes with the heaviest traffic are in fact operated most economically by trams. For other routes, technical considerations have to be taken into account. Elimination of tram tracks is indicated at different crossroads and in narrow streets, as well as on routes with light traffic. The transformation of certain routes or sections must not upset the continuous operation of the system as a whole. Comprehensive modification of the system would be inescapable.

The heaviest traffic in all of the area served by the BVB is in the valley in the central part of the city. Public traffic here is just as vital for the old city as is private transport. A new public thoroughfare must therefore be provided for one of the two. Traffic would go un-

1. Converted at an exchange rate of U.S. $23 to 100 Swiss francs.

derground at certain crossroads only. On the longer route sections with some continuity, tramways will be operated at a second level and the tracks laid underground.

This underground tramway will be extremely costly, and its construction will be spread over a number of years. Since technical progress is constantly being made in this field, it is highly inadvisable to study the underground tramway from the point of view of present tramway operations only. When determining the tunnel cross section, technical developments likely to occur over a long period of time must be taken into consideration.

Mass transport will be provided by rail, but the word "rail" must not be taken solely to mean the traditional two-rail steel track. Paris has replaced the rails on one of its subway routes by a running surface for rubber-tired wheels, a special lateral wheel assembly guiding the vehicle and taking the place of the wheel flange. Another technical variant is the "guided road" for normal size buses, comprising a guiding rail laid in the axis of twin-running surfaces for the rubber-tired wheels. The tunnel for the underground way will therefore be designed to take buses with a clearance of 50 centimeters (20 inches).

The length of the underground system must be limited because of the high cost of construction. From the operating and traffic standpoints, a suitable basic alignment would be in the shape of a cross with the point of intersection beneath the Barfüsserplatz. The four extremities of the cross could emerge at street level at a greater or shorter distance depending on the traffic in the underground tramway and the volume of surface traffic.

It is difficult to create an ideal transport network in a city where the development of the transportation system has taken centuries. It is an error to make too many changes, where transport service has developed a pattern as a result of established means of communication. Although theoretically a sound transport network should be developed identically in every direction, this is not possible in the case of Basel. The territory's boundaries are a short distance away, and the populated zone encroaches on the administrative limits of the city. To take account of the direction favored for the city's expansion, a number of radial routes, besides transversal and peripheral routes, must be retained in the greater city area.

The city streets must satisfy the differing requirements of long distance traffic, of regional traffic and of local traffic; short distance traffic has the heaviest volume.

THE STREET NETWORK

To a great extent the streets of the city in the central district still present a complex, typically medieval structure. Only by appropriate measures over the course of years will it be possible to change the existing street system in accordance with a new general plan and distribute the streets clearly into main thoroughfares and secondary roads. A limit will have to be set on the number of main thoroughfares for reasons of economy as well as of traffic.

The main thoroughfares must be radial streets for heavy traffic, leading from the center of the city in all directions to the peripheral districts and the suburbs, and be partly extended in the form of roads. The fanlike structure of these radial streets must be completed by tangent streets to enable traffic to move from one peripheral district to another or to turn away from the city-center traffic on bypasses.

Liaison of the city with the superhighway is another important link. It would be an error to bring superhighways to a stop at a point distant from the gates of the city. Their link with the system of main thoroughfares should be such that superhighway traffic can be easily distributed in all directions.

Secondary roads must also be adapted to the framework of the main thoroughfares. Those serving only residential districts should be narrow; narrow streets with heavy traffic should be restricted to one direction. One-way streets should be planned in pairs with a short distance between any two such streets, normally not more than one block. Two one-way streets forming a pair can carry a greater volume of traffic than a single two-way street, whose width is the same as the sum of their respective widths. In addition, the capacity of crossings is higher because the number of possible changes in direction is limited, and left-hand turns are easier to make. But one-way streets must be planned only to the degree required by the volume of traffic.

The normal width of traffic lanes has been fixed uniformly at 11 feet 6 inches. The number of lanes can be determined on the basis

of traffic counts and of the estimated future importance of the traffic. Ramp gradients will not generally be over 6 percent. In the underground thoroughfares, the steepest gradient will be 5.4 percent. Curbside parking space and parking lots will generally be provided only on the right-hand side of the street. An exception will be streets adjacent to a one-way street where left-hand parking will be authorized.

At new intersections, only the obtuse-angle crossing, preferably right-angled, and the fork junction will be allowed. Traffic circles are not recommended, since their capacity is sufficient only with a considerable diameter, and it is seldom possible to free the necessary space in the urban zone. The many star-shaped places comprising more than four important streets will be redesigned to comply with the principles laid down, either by providing one-way streets or barring access to certain streets.

Tram stops will be placed before crossings so that the stops at traffic lights correspond to the normal stops for passengers boarding or alighting. Motorbus stops, however, will be located after crossings. A bus which has stopped before a crossing prevents traffic from turning to the right, cannot rejoin its own file without impeding traffic, diminishes the capacity of the crossing, and hinders visibility.

The majority of radial streets have the drawback of not extending to the center of the city, considered the destination of major interest. There is a lesson to draw from this. If the streets leading to the inner city were well laid out, the inner city would be crossed by a large volume of traffic not destined for it, and merely in transit. But traffic planning should seek the opposite result and detour all superfluous traffic away from the heart of the city, and provide tangent streets around the central district to make for easy communication with the radial streets and to be able to absorb transiting traffic.

Experience has shown that the nearer a tangent thoroughfare is to the congested zone the greater its efficiency. But it must not be so close to this zone that it is itself overloaded. The Basel metropolitan area is so extensive that a number of tangent thoroughfares should be provided.

Some thoroughfares should be extended in the form of radial streets—this is particularly efficient in protecting the center of the city from all transiting traffic.

The points of intersection of the tangent thoroughfares with each other and with the radial streets are of particular interest. Their general system of distribution should in no case be brought close to the center of the city.

CHANGES PERTAINING TO CITY PLANNING

The Superhighway Terminal. The volume of traffic absorbed by superhighways should not be greater than the traffic volume of the streets which feed it. Examples in other countries show that it is not advisable to locate the superhighway terminal either at considerable distance from a large city or in its center.

The superhighway must not be considered as a self-contained unit. Co-ordination with ather public thoroughfares and traffic procedure at the terminals must be studied. The important information provided by traffic counts was interpreted with particular care with regard to the superhighway. Major traffic displacement could be observed in the urban zone.

TABLE VII—PARKING SPACE REQUIREMENTS IN 1980

Central Zone of the City	*Parking Spaces*
On the basis of:	
Number of vehicles registered	5,000
Counts conducted by post cards	4,160
Number of active and resident persons	5,150
Average	4,700
Periphery	
On the basis of:	
Counts conducted by post cards	4,610
Number of active and resident persons	5,050
Average	4,850

On weekdays, the origin and destination of superhighway traffic is the center of the city. On Sundays, the business life of this zone is dormant, and traffic is less. As the superhighway traffic draws closer to the city, it branches out into a greater number of channels. At each turning, there is a drop in the traffic load on the superhighway and the capacity of the main heavy-traffic streets is put to less efficient use. From this emerges the possibility of using available capacity to provide for a different kind of traffic.

This is what occurs, for the terminal section of the superhighway is used to a great extent by short distance traffic. Streets thus lose their superhighway aspect more and more, apparent if the composition of their traffic is examined. It is therefore necessary to go from the technical norms of superhighway construction to those of urban street layout.

The Parking Problem. The setting of sites for large new garages can be accurately determined only where the land is public property. Where this is not so, the sites of new parking lots and garages can only be approximated. Nearly one-half of the 6,100 parking spaces available today on the streets and squares of the city center will have to disappear between now and 1980 to make way for moving traffic.

EXECUTION OF THE PLAN

If the transport plan as a whole is approved, the first practical measure will be to modify the layout of some of the riverside roads at a number of points in the city.

It need hardly be emphasized that the plan will be carried out in a great number of different stages, distinct from each other, with each making for a definite improvement. The intermediate stages will be particularly effective and done in such a way that work interruptions for any reason will not in themselves cause inconvenience. On the surface and sub-surface work, progress will be so regulated that the different stages of construction will be mutually facilitated. Construction of the underground tramway will not cause long traffic interruptions in the streets concerned.

Expenditures have been estimated separately for the most significant stages in the application of the plan. Costs for projects of this magnitude cannot be accurately estimated before final studies are available.

If, over the 23-year period, an annual expenditure of 50 francs were allocated for each of the 215,000 citizens, the total amount made available would be 236 million Swiss francs ($54,280,000). The cost of the works planned, therefore, remains well within the limit which other municipal administrations long ago allocated for their traffic systems.

Is this expenditure profitable from the standpoint of improvement of the traffic network? It is not possible to calculate the profit

from new works on public thoroughfares. There is no doubt that they offer considerable benefit to the general economy. If they are not undertaken, the economic life of the city's center sooner or later will deteriorate. With public transport, on the other hand, comparison can be made between expense involved and advantages gained.

According to estimates of the BVB, the mere cost of operating the tramway services increases annually by 950,000 Swiss francs ($218,500), if the average commercial speed drops by one kilometer per hour. This annual increase of 950,000 francs corresponds to an invested capital of nearly 25 million Swiss francs ($5,750,000). An expenditure of 100 million francs ($23 million) for new works to avoid a drop from seventeen to thirteen kilometers per hour in commercial speed would therefore be fully justified.

The underground tramway will provide traffic with an extra surface at a cost not exceeding 25,000 francs ($5,750) per meter.

To make a similar area available to surface traffic, the streets would have to be widened by seven meters to provide two traffic lanes. From an economic standpoint, construction of the underground would therefore appear to be a profitable undertaking, if the cost of widening the existing streets is in excess of 25,000 francs per meter. Taking account of tax returns on buildings, cost of demolition and reconstruction, as well as of the increase in capacity of the crossroads, the underground is fully justified wherever the price of land is in excess today of 600 francs ($138) per square meter.

If the general traffic plan as described is approved, three practical measures can be adopted immediately.

1. The works of primary urgency to be undertaken during the period up to 1970 will be studied in close detail. The studies will be pursued up to the stage immediately preceding the start of work. This will be the case in particular of the first stage of construction of the underground tramway in the center of the city.

2. The plan may be modified; city planning will integrate the whole of the traffic plan into the planning for the period extending up to 1980.

3. The planning of traffic will be pursued on a permanent basis and adapted to presently unforeseen developments.

The Old Colony Transportation Problem

JAMES E. LEE

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IT is fair to say that Quincy, Massachusetts was built by "public" transportation, here meaning the privately financed railroads and electric lines before the rise of automobiles. In the period of the city's greatest growth, from 1850 to 1930, the population rose from 5,000 persons to almost 72,000. This period coincides with the years of growth, expansion and vitality of rail transportation. Subsequent to 1930, rail-borne commerce began to diminish, as did population growth in Quincy. But there the parallel ends, since the city's population continued to grow slowly while rail activity, past its crest, began to decline. So it was that a city, largely laid out under the influence of and in adjustment to mass public transportation, passed into an age dominated by individual private motor cars.

It is ironic that a city, the site of the Granite Railway, the first significant commercial railway in North America, should find itself in the position many years later of having to pass judgment on the future usefulness of the railroad as a means of transportation. That is exactly the magnitude of the question, and it must not be avoided. Other questions of cost and social or political implications must also be considered, but they pale in comparison with the central issue.

As many people believe, it is most meaningful to discuss rail transport and transit in relation to highways, motor vehicles, air-

lines, ships, and pipelines. All the latter have long held or have recently taken over functions that were common interests and activities of railroads. All have contributed to the sharp decline of economic strength of the rail carriers. Faced with the extremity of bare survival, many eastern railroads have been eager to dispose of their most demanding and least profitable service, the carrying of passengers. The automobile in particular has brought about the fall of rail commuter service. Any discussion of rail commutation must therefore take highways and automobiles into fullest account. Any plan to re-establish such rail service must be conditioned by realistic understanding of the known history of railroad difficulties and of the ascendancy of highway motor vehicles.

In the case of Old Colony rail commutation, with occasional exceptions, patronage had been steadily decreasing for many years before the opening of the Southeast Expressway. Renewal of such service without the assurance of adequate patronage in the foreseeable future could amount to pure folly. The general desire to relieve congestion on the highways and city streets, to ease parking problems, and to provide suitable transportation to large numbers of people in all weather and with greatest safety of movement is laudable. But it is also irrelevant without the public's interest and co-operation.

KINDS OF URBAN PASSENGER SERVICE

As a counter agent to the chaos and waste induced by extensive use of individual motor vehicles, public transportation in an open, competitive economy can be successful, but only if it offers a more attractive alternative for its riders. Broadly speaking, it must effectively meet demands for higher standards of performance by the basic criteria of speed, comfort, economy, safety, reliability, convenience, and adaptability. Since the automobile in some measure promises most of these to its user and greater flexibility of movement in addition, the attainments of rail service must surpass them and be consistently maintained. The fact that increasing traffic congestion makes the individual motor vehicle less safe, less swift, and less comfortable should never be a reason for lowering the standards of rail service, if reliable patronage is to be assured.

"Commuter service," as already referred to indirectly is here

understood to be the daily movement of regular patrons over a considerable distance, more than 5 and less than 50 miles, from an outlying place to some center of interest. "Rapid transit" means mass transportation for in-lying movements within a densely settled area. The terms intermural and intramural or inter-urban and intra-urban are equally appropriate to describe the two types of movement. "Rapid transit" and "commuter service" are readily distinguished in their physical characteristics. "Commuter service" utilizes railroad-type equipment, cars of conventional railroad width and length, with steps for loading and unloading along rail-height platforms, although floor-height (high-level) platforms can also be used. "Rapid transit," on the other hand, requires short, narrow cars to negotiate subway tunnels, and such cars ordinarily unload and load only at floor-height (high-level) platforms. Because the narrowness of the cars requires that platforms be built close to the tracks, "rapid transit" facilities are not compatible with conventional railroad service.

Two other words conventionally used, "mass" and "speed," can describe the difference between "rapid transit" and rail "commuter service." Because of the densities of settlement of the areas served and the distances involved, one service has been concerned with moving large masses of people in tight quarters, while the other has moved fewer people over greater distances and through relatively low density surroundings.

Before the propriety of reactivating Old Colony service can be established, a prior determination must be made as to the particular type of service desired and the facilities required for it. Such a determination is based on examination of more possibilities than the varieties of rail service alone. Such possibilities as they pertain to the South Shore area include the following:

1. Increased reliance upon individual motor vehicles operating on an improved highway system, with: possible establishment of tolls; minor supplementary bus service; Old Colony tracks retained for freight service only.

2. Improved bus service to relieve automobile congestion, with: major highway improvements; Old Colony Railroad for freight only.

3. Establishment of express commercial truck and bus highway

on Old Colony right-of-way with: abandonment of tracks; prohibition of private automobiles; or the continued use of individual vehicles and buses plus one of the following.

4. Rapid transit extension of the Metropolitan Transit Authority, with: optional financial and administrative autonomy; high-level platform loading; restricted conventional rail freight service; electrified cars or dual function cars (combination straight electric and diesel-electric power).

5. Rapid transit extension with low-level loading, with: Steps and trap doors on equipment to accommodate high- and low-level station platforms; reconstruction of Old Colony station platforms unnecessary; no interference with any concurrent, conventional rail service; same equipment power options as in 4, electrified cars or dual function cars.

6. Rail commuter service with diesel-powered equipment: using rail diesel cars or conventional trains with locomotive; with terminus at South Station in Boston with possible transfer at Savin Hill; with optional through-service south and east of Braintree.

7. Rail commuter service with electrification, with: termini at South Station in Boston and Braintree; supplementary service with dieselized equipment; utilization of low-cost 25,000 volt, 60-cycle alternating current (AC) type of electrification.

8. Unified metropolitan rail commutation service, with: construction of a direct rail link between North and South Stations in Boston; choice of equipment power options, AC electrification for heavily trafficked lines and dieselization for outlying lines, or all diesel; multiple-unit passenger service; establishment of new central downtown station in Boston with rapid transit and/or helicopter connections to Logan International Airport; establishment of "through" commuter routes, namely, Braintree-Waltham, Framingham-Lynn, Needham-Wakefield, to be established by pairing of lines of comparable traffic.

All these possibilities are forms of land surface transport. Two other obvious media of transportation are water and air travel, omitted for the following four reasons:

Short distance air travel is at present inefficient and requires large amounts of air space for safety to transport small numbers of people.

The most flexible present aircraft, helicopters and the experimental Vertical Take-Off and Landing (VTOL) craft, require well-separated and fixed termini that are not readily suited to the mass transportation of a diffusely settled population.

Both air and water travel, particularly the former, are highly susceptible to adverse weather conditions.

Water service, by definition, is confined to movement between points on the fringe of settled areas.

These objections should not blind us, however, to future technological improvements in these kinds of transport. Nor should we forget that possibilities which now exist only in imagination may become realities in the years ahead. The principles of pipelines and conveyor belts, for example, have never been applied to passenger transportation on a large scale. (The movement of people through a tubelike subway in pneumatically driven capsule compartments was a source of experiment at the turn of the century while, in our own time, moving sidewalks are joining escalators as an application of the conveyor principle.) Finally, we must consider the extent to which a combination of the telephone with closed-circuit television, the videophone, when coupled with automation in production and record-keeping, might reduce the need for the concentration of large numbers of people in centralized places of employment.

Many significant changes in communications and living habits lie before us. While some of the remarks just made may seem digressive or fanciful, what they have in common that makes them significant is the uncertainty of the future pattern of urban affairs. Conventional mass transportation in any form requires a somewhat rigid pattern of movement and facilities. Yet people's activities have gradually been becoming more and more flexible and informal. The automobile has both adapted to and produced this change. The future usefulness of urban mass transportation depends upon the existence or appearance of natural limits to such change. Those limits seem obvious in a city such as New York, but are less obvious in a metropolitan area such as that of Boston. The intensity of human activity in central Boston can continue to diminish while that in the surrounding area increases. Decentralization is more than an idea. It is a living fact.

If we restrict our discussion by recognizing the limits imposed by the available products of technology, we observe that the superabundance of highway motor vehicles is defeating its own potential freedom of movement and becoming its own greatest obstacle. More highways and parking facilities must be built and much precious urban land must soon be sacrificed, or else an alternate mode of transport must be accepted and must coexist successfully with automobiles.

The alternative, within present technical limits, is the use of wheeled vehicles on a bounded, restricted right-of-way. Swift, controlled, mass conveyance on public ways is not possible. The choice of "rail" or "rubber" remains to be made. Rubber-tired vehicles, with the advantage of flexibility, can readily move off a special, restricted right-of-way to specific destinations. Their travelway is less complex and easier to maintain, but they are subject much more to the effects of weather. Their advantage of flexibility has a corollary drawback, susceptibility to collision or loss of control. The load-carrying capacity of such vehicles, as presently built and used, is more limited than that of rail vehicles, and the space required for safe maneuverability is greater. The conclusion would be that rubber-tired highway transport is less efficient in use of space, less dependable in adverse weather—unless we consider radiant heating of highways—and less capable of mass transport than rail-operated vehicles. Their superior virtue of flexibility is an equalizing factor, however, if a restricted right-of-way for primary movement is provided. It is interesting to consider a dual-service vehicle adaptable to both road and rail operation. Many experimental and limited service vehicles of this kind have been built, but nothing applicable to present commuter needs has yet been devised or produced.

This review of the possible modes of transport brings us cautiously and by process of elimination to consideration of rail service as a useful immediate means of partial relief for urban transportation difficulties in the Quincy region.

In considering rail service, already suggested, the choice must be made among "rapid transit" operation, rail "commuter service," or a service which combines some features of each. To make the choice we should set down the criteria that the service must satisfy.

1. *Speed.* The users' journeys must be completed as swiftly as possible. Station stops must be minimized.

2. *Convenience.* Stations must be well located in the areas they serve, must be readily accessible and, where appropriate, must have ample parking facilities. The operating schedule must be appropriate to the users' habits and needs.

3. *Comfort.* Equipment and stations must be well maintained, clean, spacious, generally attractive and relaxing. Users must be attracted and pleased by the service, not repelled or discomfited.

4. *Economy.* The cost of using the service must be comparable to or less than the cost of using other means of transportation.

5. *Safety.* Rail transport's traditionally good record of safety must be conscientiously maintained. Whenever assured patronage warrants extension of high-speed rail service, grade crossings with highways should be eliminated.

6. *Reliability.* Rail operations' greater ability to contend with inclement weather must be exploited, facilities must be maintained, and schedules must be adhered to rigorously.

7. *Adaptability.* Any one form of rail transport should be rated on its ability to accommodate a variety of service demands.

If the validity of these criteria is conceded, we may then attempt to appraise the relative standing of the various types of rail services.

A. RAPID TRANSIT EXTENSION OF THE M.T.A

1. *Speed.* Well-separated stations and electrified equipment's capability of rapid acceleration should provide swift movement from Braintree to Savin Hill or Ashmont but only M.T.A. speeds thereafter. Rating—good.

2. *Convenience.* Direct connection with all M.T.A. lines. Rating—very good.

3. *Comfort.* Equipment employed tends to be light, short and narrow. Highly susceptible to crowding. Rating—fair to poor.

4. *Economy.* Preliminary estimates indicate reasonable fares. Rating—good.

5. *Safety.* With grade separations from Braintree to Boston. Rating—very good.

6. *Reliability.* Across the nation, lightweight electrified rapid tran-

sit has established a tradition of dependability. Rating—very good.

7. *Adaptability*. Conventional rapid transit employs platforms and clearances which are not compatible with other forms of rail service. Rating—poor.

B. RAPID TRANSIT WITH LOW-LEVEL LOADING

1. *Speed*. Same as for "A," rapid transit extension of the M.T.A.

2. *Convenience*. Same as above.

3. *Comfort*. Same as above.

4. *Economy*. May benefit from lower construction costs. Rating —good.

5. *Safety*. Partial dependency on step loading incurs slight additional hazard. Rating—good.

6. *Reliability*. Sharing of trackage may occasionally disrupt tight schedules. Rating—good.

7. *Adaptability*. The use of steps and trap doors with high- and low-level loading tolerates track level platforms after leaving M.T.A. tracks and permits mixed use of tracks. Rating—excellent.

C. RAIL COMMUTER SERVICE, DIESEL POWERED

1. *Speed*. Limited number of stations and easier track curvature can increase speed over rapid transit limits in outlying areas, but some loss may be experienced in South Station's stub terminal congestion. Rating—very good.

2. *Convenience*. Necessity for further pedestrian or M.T.A. travel from terminal. Rating—good.

3. *Comfort*. Longer, wider, heavier equipment and fewer stops to load and discharge passengers lessens interior disruption and allows more spacious seating. Rating—good.

4. *Economy*. Slightly higher initial capital outlay than rapid transit. Rating—good.

5. *Safety*. Same as for "B," rapid transit with low-level loading.

6. *Reliability*. Same as above.

7. *Adaptability*. Allows free and varied pattern of rail activities including re-establishment of passenger service to Brockton, Plymouth and the Cape. Rating—excellent.

D. RAIL COMMUTER SERVICE, ELECTRIFIED

1. *Speed.* Rapid acceleration, few stations, mainline track. Rating—excellent.

2. *Convenience.* Same as for "C," rail commuter service, diesel powered.

3. *Comfort.* Same as above.

4. *Economy.* Utilization of 25 kilovolt (KV), 60-cycle AC power system should provide for lowest capital outlay of group here under consideration. Rating—very good.

5. *Safety.* Same as for rapid transit with low-level loading.

6. *Reliability.* Same as above.

7. *Adaptability.* Same as rail commuter service, diesel powered.

E. UNIFIED AND ELECTRIFIED METROPOLITAN RAIL COMMUTATION SERVICE

1. *Speed.* Same as for "D," rail commuter service, electrified.

2. *Convenience.* New downtown Boston rail link maximizes internal accessibility of total metropolitan area. Rating—excellent.

3. *Comfort.* Same as for "C," rail commuter service, diesel powered.

4. *Economy.* Same as for "D," rail commuter service, electrified.

5. *Safety.* Same as for "B," rapid transit with low-level loading.

6. *Reliability.* Same as above.

7. *Adaptability.* Same as for "C," rail commuter service, diesel powered.

In order to arrive at crude scores for the various possibilities, an "excellent" rating is set to be worth 4 points, "very good" 3 points, "good" 2 points, "fair" 1 point, and "poor" to be worth no points. Applying these ratings to the five rail possibilities, we obtain the following results:

Factors	*Rail Possibilities*				
	A	B	C	D	E
1. Speed	2	2	3	4	4
2. Convenience	3	4	2	2	4
3. Comfort	1	1	2	2	2
4. Economy	2	2	2	3	3
5. Safety	3	2	2	2	2
6. Reliability	3	2	2	2	2
7. Adaptability	0	4	4	4	4
Scoring	14	17	17	19	21

The optimum score is 21, achieved only by "E." The effective minimum may reasonably be considered to be 17, the lowest acceptable score. It would be possible, by improving some factors, to exceed the optimum.

Before pressing the case of these rail service possibilities, it seems appropriate to consider recent technical studies of the Old Colony transportation problems.

THE 1959 STUDY

A study in 1959, "Report to the Old Colony Area Transportation Commission on Plans for Improved Suburban Transit,"[1] is of inestimable value to anyone studying the Old Colony transportation problem. It both reviews and explains most of the background information pertinent to the kind of understanding that this subject requires. However, like most comprehensive reports, there are some points on which differences might logically arise and on which technical views might differ.

Old Colony area transportation must be part of the total metropolitan Boston transportation system. The problems of suburban rail service are obviously not confined to the South Shore area. A satisfactory solution for the South Shore will integrate naturally with a larger solution for the total Boston metropolitan area.

The standards of usefulness and acceptability for rapid transit and suburban commuter service are equally applicable to this area. Also, through rail service must be provided. A rapid transit scheme which would make it necessary to build high-level platforms of limited clearance in conjunction with gauntlet tracks would obviate the possibility of high-speed operations of rail service south of Braintree for vacation, holiday and excursion trains. Such service is important.

There are other important considerations in studying multi-use rail transportation. These include development of the most efficient power systems, taking into account the need for power substations, auxiliary transmission lines and heavy duty overhead catenary. It is reported that the use of a 25 KV, AC system can reduce the cost of electrification as much as 50 percent and may reduce total capital outlay. New types of cars, such as two-level elec-

1. Prepared by DeLeuw, Cather & Company, Engineers, Brookline, Massachusetts.

trified cars that would operate on both rapid-transit and regular railroad trackage and in both types of stations should be investigated. In addition, speeds above conventional travel limits are important in attracting transit usage.

Perhaps the most difficult part of any transportation study involving the collection of fares is making estimates of patronage. While such estimates relate to patterns of travel demand, usage is largely influenced by cost, time saving, and convenience. Events with regard to travel in the area make estimates of usage more difficult than those normally found in similar studies. It is not surprising, therefore, that questions have been raised concerning the reasonableness of estimates of future patronage of a re-established rail service.

The patronage of the Old Colony was increasing from 1952 to 1957 when a fare increase interfered. Another fact is that the ridership of the M.T.A. electrified Highland Branch is "ten times greater" than that of the Boston and Albany Railroad's operation of the same branch.[2] The question of metropolitan rail passenger service seems to be a question of "how," not a question of "if."

THE PREFERRED POSSIBILITY

On the basis of the preceding discussion as well as considerable study and reflection, one rail service possibility stands out, above the other mass transportation services considered. This possibility is *the establishment of a metropolitan-wide, high-speed, publicly owned and operated rail commutation service.*

What does this entail? It means, first of all, a direct rail link between North and South Stations in Boston. This is both possible and practical. If an expressway through Boston is possible—an accomplished fact—then the railroad connection is equally possible.

What about its practicality? Let us read another recent commentator[3] on the subject:

> In the Boston area, the sufferings of Suffolk County and the suburbs would be greatly reduced by breaking a tunnel through about a mile and a half of soft slate, putting Boston's North and South stations on the same

2. Report No. 7 of the Greater Boston Economic Study Committee.

3. Stanley Berge, "How Commuters Can Have Their Trains," *The Atlantic Monthly*, May, 1960.

through tracks. Such a bold stroke would not only break the city's ancient bottlenecks by transforming its two stub-end stations into through stations; it might be the welcome signal for finally getting New England's most important railroads—the New Haven and the Boston and Maine—to work as a winning team. Certainly each road has been finding solo operations a losing proposition.

A new direct link between the South Shore and Back Bay could also be added by constructing a new railroad bridge across the Fort Point Channel, east of the Southeast Expressway structure. This type of connection, advocated by John Herbert, editor of the *Quincy Patriot Ledger*, would allow South Shore trains to move directly to this promising area of Boston.

The proposal by Mr. Berge, Professor of Transportation at Northwestern University, certainly seems to complement the recommendation of a special staff of the United States Senate Committee on Interstate and Foreign Commerce which urged the merger of New England railroads into one company. A further recommendation[4] by this group was to "consider setting up a Government corporation to own and operate passenger trains and stations, if the railroads can't do it profitably."

Mr. Berge in his article also emphasizes two other important points. The first, in his words, is this:

> A fact too often overlooked in discussions of the metropolitan transportation problems is that efficient movement of freight within and across the urban area is just as important as efficient movement of passengers. Hence, any future planning for railroad commuter services and other passenger services should aim at maximum utilization of tracks, equipment, and other facilities *by both freight and passenger trains*. Is this being done today? The answer is No. Railroad executives and city planners are still struggling with proposals for commuter facilities and for rapid-transit extensions exclusively to take care of passenger traffic. It is not surprising that most of these plans are slow to get public acceptance. Their failure to obtain financial and general support is primarily the result of a fundamental fallacy in metropolitan transportation planning; namely, that because no more than twenty hours per week of use can be expected of commuter railroad and rapid-transit facilities and personnel, such facilities can never be made self-supporting and their operation will always incur a

4. Quoted from *U.S. News and World Report*, Jan. 16, 1961.

deficit. Since deficits must be carried either by taxpayers, in the case of transit lines, or by shippers and stockholders, in the case of commuter railroads, it is hardly to be expected that metropolitan transportation plans involving extensive deficit financing should be greeted with widespread enthusiasm. In our enterprise system, the public is apt to look askance at any industry, even in the public service, which openly declares that it cannot exist without direct public subsidies on a permanent basis.

Why is it that so many people think of the metropolitan transportation problem simply as a mass-transit problem? To be sure, mass transit by bus and rapid-transit lines is certainly a vital part of urban passenger transportation, but unfortunately it is not suitable for long-distance extensions, as metropolitan travel reaches out fifty miles or more from the central business district. Neither are mass-transit facilities and equipment particularly suited to the transport of mail, express, and freight, which must also be carried if metropolitan rail lines are to become self-supporting. Hence, rather than extend rapid-transit lines far out of the central cities into thin-density territory, why not avoid duplication, waste, and frustration by assigning responsibility for relatively long distance metropolitan transport of both passengers and freight to coordinated metropolitan railroad systems and turn over the closely spaced stops and high-density urban transport of passengers to the transit lines. The railroads would thus become a super rapid-transit network which could be effectively coordinated with an inner network of urban transit services.

The additional point is stated by Mr. Berge as follows:

For metropolitan railway operations, electrification must be regarded as the next important step to be taken after unification of tracks and stations. Under high-density traffic conditions, such as prevail in metropolitan service, electric trains are more efficient and economical than diesel-powered trains. In the long run, using the high-voltage AC system, fuel and maintenance costs will be less for electric than for diesel power. With more traffic concentrated on fewer tracks in a coordinated system, the time will be ripe for a new era of American railroad electrification. By that time, experiments now being made may have perfected a system of automatic train operation by remote control on electrified routes. Louis Armand, former president of the French National Railways, [stated] in 1955 that automatic operation of electric trains would in the future be considered just as practical as automatic electric elevators are today.

If Mr. Berge is correct—the writer independently reached and holds to many of the same conclusions—then the appropriate rail

service for the Old Colony area is "E" as listed earlier, unified and electrified metropolitan rail commutation service. Second best, because it is only a partial solution is "D," rail commuter service, electrified, or its approximate equal except for power system. The third best, "C," rail commuter service, using rail diesel cars, can lead to circumvention of the best solution, and holds less promise of being self-supporting; by failing, it could discourage future attempts to establish effective suburban commuter service on a metropolitan basis.

Fourth choice but not very choice is "B," the service described as rapid transit with low-level loading. This possibility is desperate in character since it would seem to signify defeat of any genuine hope for a metropolitan commuter system. By utilizing both high- and low-level loading it would avoid rapid-transit type platforms along Old Colony tracks and thereby avoid extermination of free moving, mixed rail traffic for the Old Colony. It would, however, lose the advantage of the 25,000 volt AC power system and would be an admission of failure to accept other means of convenient commuter access to downtown Boston.

The last and least choice is "A," rapid transit extension of the M.T.A. on the Old Colony tracks. This possibility is desirable only as an alternate to the intolerable highway problem with its self-defeating cycle of more traffic, more new roads, more traffic, ad infinitum.

Other possibilities for solution of the suburban commuter problem include "increased reliance upon individual motor vehicles," improved bus service in one form or another, and some other presently impracticable schemes. All these remaining possibilities lie below the threshold of acceptability either because they contribute to existing problems, such as inefficiency, or are not sufficiently well developed or conceived to cope with such problems.

FURTHER PRACTICAL CONSIDERATIONS

The re-establishment of rail commuter service in the Old Colony area involves a decision on more than the type of service. A choice and commitment must also be made on the type of organization and financing most appropriate to that service.

The types from which a choice can be made are these:

1. Public ownership, operation and financing.
2. Private ownership, operation and financing.
3. Public ownership, private operation under contract, and public financing.
4. Public ownership, private operation and financing under leasehold.
5. Private ownership, private operation, and public financing.
6. Private ownership with public operation and financing under the terms of a limited lease-contract.
7. Public ownership, public operation, and private financing.
8. Private ownership, public operation, and private financing.

"Operation" means the management, supervision and labor required for running the service. "Financing" means the initial capital investment required for establishing service plus the responsibility for absorbing any deficits which might arise. "Private financing" includes any possible private investor, not just the present owner of the Old Colony right-of-way.

Examination of the list of types of possible organization and financing shows some may reasonably be eliminated.

To begin with, it does not seem likely that a private investor who owns the property and has financed improvements would hand over operation to a public agency, as in 8, unless very special conditions were attached such as more favorable labor arrangements or tax waiver to assure otherwise doubtful profits.

Also doubtful is the likelihood of 7, private financing of a publicly owned and operated facility. In a case such as this the typical investor would view the matter as pure philanthropy.

Type 6 is basically improbable unless there was a guarantee of tax waiver, tax payment or guaranteed benefit to the owner. Such an arrangement would, generally speaking, grant the owner the assets and the public the liabilities.

Type 5 amounts to outright, blanket subsidy; it is the converse of type 7 in that the public now becomes the philanthropist for a private operator.

Type 4 would be a possibility, except that the private investor accepts the liabilities and the public takes the assets. Even though tax exemption is built in, the only incentive for the investor would be the assurance of highly profitable operations without deficits in

order to absorb and transcend the capital outlay. This type is essentially the converse of type 6.

Type 3 is theoretically feasible except that the public, as an owning and financing group, would be relinquishing direct control and management of a sensitive operation to another group relatively free from the consequences of its own actions. This is the converse of type 8.

Type 2 represents that which, at this moment, is a proven failure. The present owner is unable to finance and operate successfully and the number of other investors who would make the attempt are few. Even if such an investor were found, and even if the Old Colony railroad properties were made tax exempt, the service would possess no more permanency than any other private speculation. The service to be established promises real benefits in the form of savings to towns, cities and the state, and convenience to the citizenry, but these are indirect benefits compared to profits from over-the-counter sale of tickets.

Type 1, the public ownership, operation and financing of suburban commuter rail service has been and continues to be the preferred choice. Public financing through the issuance of general obligation bonds clearly offers the most advantageous terms. Public ownership automatically reconciles the property tax problem of setting an unwanted precedent in granting blanket tax exemption or relief. Public operation can and should provide public service specifically orientated to the needs and desires of the public it serves, a compelling factor when public satisfaction is the key to its success.

This list of eight types is not exhaustive. By slight changes in the nature of the three factors of ownership, operation and financing, it is possible to produce seemingly endless variations. The list is sufficient, however, to provide a general setting for discussion and choice. And the *choice is for public ownership, operation and financing* of the suburban commuter system. If the public takes the risk, then the public should enjoy the benefit.

After conceding the merits of a public commuter service, it is appropriate to describe in some detail the manner in which its control and cost will be distributed. Since the actions taken in regard to the Old Colony area may set a pattern for the entire Bos-

ton metropolitan area it is worthwhile to comment in the larger context. First, it is necessary to make the obvious statements that those who benefit should pay and further that those who pay should have "the say." The communities that will benefit are the suburbs and Boston itself.

The internal strengthening and relief that Boston can realize from a good commuter service is worth paying for—the relief of traffic and parking congestion, the greater accessibility to Boston cultural and commercial offerings. But, neither in the Old Colony case nor in the general suburban transit problem is the responsibility predominantly Boston's, nor should the cost or control be. Boston should make a minority contribution and should have minority representation, because the success or failure of the venture directly affects Boston's future. By far the major share of the responsibility, the cost, and the representation for the control of the system belongs to the suburban or adjoining towns and cities which will be directly served and directly benefited. The eventual picture is that of an autonomous Metropolitan Suburban Transportation Authority, financed and controlled largely by the communities it serves and tied in with, but not duplicating, the services of the M.T.A.

THE NEXT STEP

The next major step is the exercise of the Old Colony option. Before that can be done, a choice of plan for rail service must be made. This choice in turn must be completely compatible with an intelligent, workable solution of the entire Greater Boston commuter problem.

Specifically, the conclusion is that there should be established a unified, electrified (25,000 volt, 60-cycle, AC), commuter rail service, utilizing a new direct rail connection between North and South Stations, serving all of metropolitan Boston's suburban communities, possessing its own public tax-exempt right-of-way, and granting trackage rights to connecting through railroads in return for reasonable fees to help defray the expenses of track and terminal maintenance. Such a system, which might be called the Metropolitan Suburban Transportation Authority, would be operated and financed independently of the Metropolitan Transit

Authority, but its operations would complement those of the M.T.A. The system, when fully developed, would terminate in the suburbs at such points as Hingham or Braintree, Canton, Dedham or Needham, Framingham, Waltham, Lexington, Reading and Lynn. At the terminals and at appropriate intervening points there should be ample parking and loading areas.

With such a system, the choice of rail service plan for the Old Colony area, when considered by itself, is clear. The preferred service here identified as "D," rail commuter service, electrified, is generally similar to "C" of the DeLeuw, Cather report except that it specifies using the 25,000 volt, 60-cycle, AC power supply. "D" is the Old Colony portion of the highly recommended "E," unified and electrified metropolitan rail commutation, the suggested solution.

The exercise of the option under "D," or a modified DeLeuw, Cather "C" plan, can be not only the first step in an improved rail system for relieving the commuter transportation problem in Greater Boston, but, by giving consideration to a North-South Station rail link, can also be a move in the direction of more efficient, more prosperous railroad service for all of Massachusetts and New England.

EPILOGUE

For those who hesitate in face of a decision to exercise the option, remembering vividly the rise of the private automobile and the decline of railroad passenger service, we agree that the private automobile is presently the dominant means of surface transportation for people in this country. To allow it to become more nearly the sole means, however, is to assure increasing and unending congestion, confusion and discomfort for the residents of our urban communities. The effort to rush a road-building program equal to the demand can be a struggle without a victory, or, if a temporary victory is won, it can be a pyrrhic victory, a victory where the losses exceed the gains. The automobile is understandably the major means of contemporary passenger transportation in much of our country but its function, although major, is neither solitary nor salutary. It alone is not enough.

ACKNOWLEDGMENTS: I wish to thank the members of the Quincy Planning Board for authorizing, at the behest of William A. O'Connell, executive vice president of the Quincy-South Shore Chamber of Commerce, my examination of this subject; Mr. George Yarrington, executive director of the Quincy Taxpayers Association and former chairman of the Old Colony Area Transportation Commission for his interest; and Professor Stanley Berge of Northwestern University for his article cited in the text. The *Quincy Patriot Ledger*, the Boston newspapers, and the pertinent telecast by WGBH-TV have been most stimulating.

Particular appreciation is extended to the people of Quincy who have made possible the continued operations of the city's Planning Department.

Finally, I must acknowledge that, although many have contributed to the formation of my opinions, the responsibility for them, except as otherwise indicated, is solely my own.

Intersections at Night

DONALD E. CLEVELAND AND CHARLES J. KEESE

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THAT our highway systems have not performed as satisfactorily after dark as during daylight hours is evidenced by the night accident rate which is approximately twice the daytime rate. The constantly increasing traffic volume emphasizes the importance of this problem, as more and more people and goods move after dark. Though the personal characteristics and motivations of these night road users pose formidable educational and enforcement problems, the vision problems created by darkness concern the engineer most. He strives to design and equip his facilities with devices that provide for the special problem of seeing after dark. One of his most important tools is highway illumination.

The most critical points in our state systems are rural highway intersections. The highway intersection, long recognized as the

point of major traffic conflict and congestion, is the limiting factor in the operational capacity of the highway. As traffic volumes have increased, it has been necessary to increase the complexity of both at-grade and grade-separated intersections. Potentialities for reduction in night accident experience at these centers of conflict, along with increased usage, have stimulated much interest and experimentation on their proper illumination.

These more complex intersections and interchanges require more exacting skills on the part of the driver, who must recognize and react to situations rapidly and accurately. These situations usually must be recognized well in advance of the point at which the maneuver must be made. At even moderate operating speeds, vehicle headlights do not provide visibility adequate for perception of the situation and for the appropriate maneuver to be made safely.

For years, highway and traffic engineers have attempted to improve intersection operations by channelizing, signing, and marking intersections. However, because of the complexity of current designs and the adverse visibility conditions frequently encountered, this approach is not entirely adequate.

Engineers naturally have turned to roadway illumination as a means of providing consistently available visibility which can encourage safe and efficient operation at highway intersections. Since the installation and maintenance of illumination systems are a substantial part of capital and operating budgets, strenuous efforts have been made to arrive at adequate designs at minimum cost. Among illumination specialists there is no unanimity of agreement on design for the variety of conditions encountered. The development of truly technical approaches to this problem of night visibility is still under way, and many approaches offering promise must be explored.

THE INVESTIGATION

In recognition of the fact that at intersections the driver frequently needs better than ordinary visibility of the driving environment, the Texas Highway Department in 1957 authorized the Texas Transportation Institute of the Texas Agricultural and Mechanical College to undertake a research project to investigate

the effects of various types of intersectional illumination and signing on traffic safety and performance. The Bureau of Public Roads, through the Highway Planning Survey research program, co-sponsored the research in recent years.

APPROACH TO THE PROBLEM

The initial step in the study was to form a project advisory committee, which pinpointed a number of specific problems and provided invaluable assistance. Personnel from cities, the State Highway Department, and the Bureau of Public Roads are currently active on the committee. Significant contributions to the project have been made also by W. R. McCasland, former staff member, and H. H. Bartel, a graduate student.

Approaching the problem, it was believed that the objectives could be attained if the answers to two questions were obtained. These are:

1. What and how well does the driver need to see to pass through an intersection with minimum hazard and with desirable operating characteristics?

2. What illumination approach is needed to provide the required visibility?

The typical approach to the intersection illumination problem has concentrated on safety experience derived from studies of reported accidents. Even with the most nearly adequate reporting systems, however, it is difficult to isolate the level of illumination as a direct cause in differential accident experience at intersections. Because of the many contributing factors to accidents and many variables in design, illumination and operation, it was decided to give minimum emphasis to this aspect. Nevertheless, accident experience at intersections considered in this investigation is being studied for possible significant clues.

In selecting the approach to the problem, much attention was directed towards providing members of the project advisory committee and Institute research staff with as much information as possible on intersectional illumination alternatives. In addition to extensive photometric studies, the use of scale models was investigated.

The main effort of the study was directed to evaluation of traffic

Figure 1

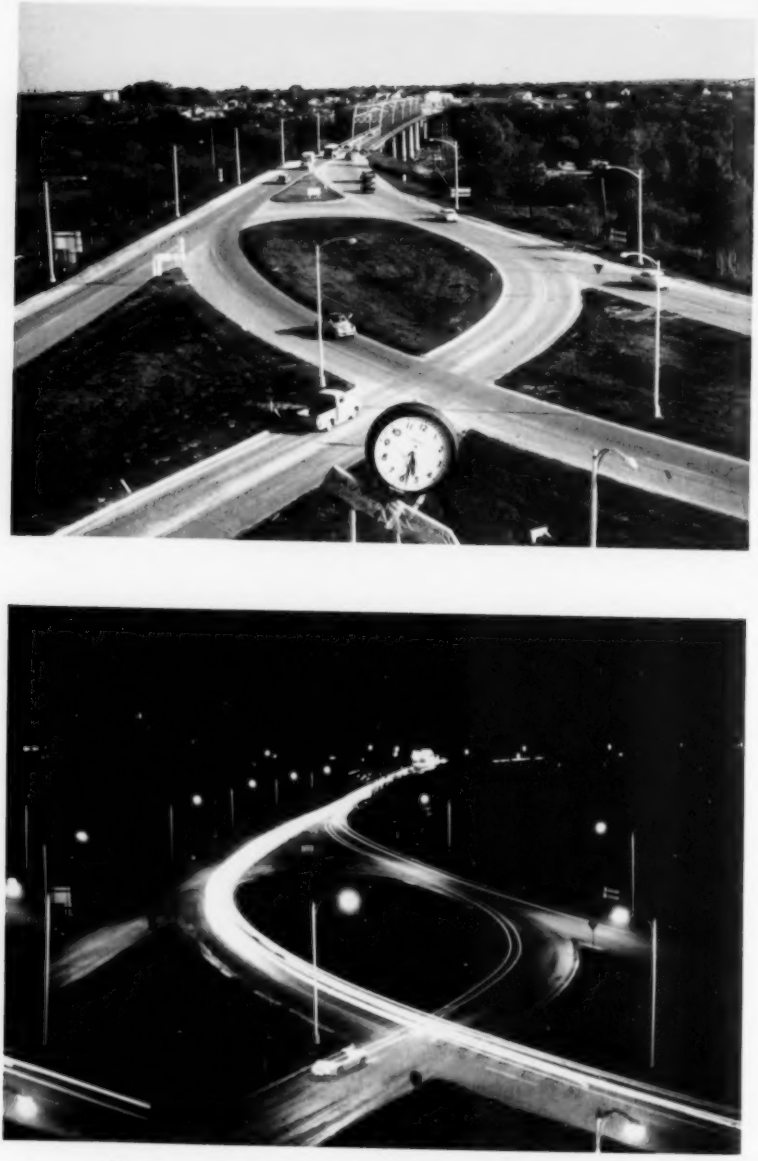

Figure 2. Day and Night Views, Austin Intersection

performance in intersectional areas. It is reasonable to assume that visibility at the intersection will be reflected in the driver's actions as he approaches and passes through the intersection. It is also reasonable to assume that the smoothness of operation through the intersection at night should be somewhat similar to that achieved in the daytime. A number of operational studies have been conducted under a variety of controlled illumination conditions to evaluate these operational characteristics. The galvanic skin reflex phenomenon has also been investigated as a tool for measuring driver-tension response to levels of illumination.

Sign illumination has been extensively evaluated with particular attention to special sign lighting fixtures and the effects of roadway lighting on sign recognition and legibility.

This article presents only a fraction of the findings to date on this continuing project. A final report on significant results will be completed in 1962. The following sections present the experiences with methods of investigation, discuss some problems encountered, and give significant findings generally indicative of the type of results being obtained.

The research workers believe that the studies generally have shown that:

1. Intersectional illumination, signing, and designing must be as closely co-ordinated as possible at the design stage.
2. No single standard illumination design is adequate for the variety of geometric and environmental conditions encountered at intersections.

SCALE MODEL STUDIES

Since many principles of roadway illumination design have been based on personal opinion, and since full-scale comparative studies are slow and expensive, early in the study it was decided to investigate the applicability of scale models to illumination research. After an intersection in Texas City had been selected for the study of full-scale illumination alternatives, a scale model of this site was constructed. Field evaluation of full-scale illumination was expected to determine the usefulness of the model as a predicting tool. The model provided an opportunity to test various lighting designs, glare elimination, and sign illumination. Accordingly,

the actual installation of intersectional illumination was delayed until after the model had been built and used in the determination of the number and location of luminaires for various alternative approaches to the problem.

A scale of 1 inch to 5 feet was selected and a model approximately 8 feet square was constructed as shown in Figure 1. This scale was based on past experience in scale model construction and available laboratory space. Experience indicated that a scale of 1 inch to 3 feet would be more desirable. It was constructed on a plywood base with "Upson Board" highways, which can easily be removed and replaced by other materials to simulate different types of highway construction materials. Plaster of Paris was used for the shoulders, and all materials such as paint, sand, and model landscape moss were furnished to reproduce the light-reflection qualities of the actual intersectional elements.

Miniature signs were built to scale and placed on the model in the same locations and positions with respect to luminaires as the signs at the intersection. A typical 400-watt mercury-vapor lamp, type II distribution, was selected as the prototype for the development of scale model luminaires. Varying illumination intensities and patterns were developed by using lens filters, rheostats, and miniature lamps. The miniature light standards, equipped with lead bases and flexible wire leads, could easily be moved about on the model intersection.

A model automobile was equipped with a periscope which allowed an observer to view the "highway" through the automobile windshield as the model was pushed along the road. Also, several "view boxes" of different designs were developed, through which it was believed observers could obtain views of the intersection similar to those obtainable through the windshield of an automobile passing through the actual intersection. These viewing devices were not successful for this purpose.

A number of studies of placement of light sources and signs were made using the model. Each member of the project advisory committee studied the model under various light patterns. Observers placed the model luminaires on the model intersection at those locations which they believed would result in significant illumination variation. The observer placed himself so that he

could as nearly as possible simulate the driver's field of vision and arranged the miniature lights to provide the desired illumination on each roadway element. These studies served as a basis for location of the luminaires at the actual intersection.

After the luminaires had been placed at Texas City, the model was compared visually with the intersection at the site. The committee agreed that the model gave a sufficiently accurate representation to be of practical value in determining illumination designs at complex intersections.

The development of the model intersection, including labor, luminaires, signs and other materials, use of equipment, and development and supervision of testing techniques, cost approximately $8,000. By using equipment and technology now available, it is estimated that another model of an intersection could be constructed for approximately $500.

OPERATIONAL STUDIES

An important part of this research has been devoted to evaluating field installations of highway illumination. Visual evaluation, accident analysis, measurements of vehicle operational characteristics, and measurement of driver behavior have been used to compare alternate approaches to highway illumination.

Major field studies have been conducted at two Y-type grade intersections, one near Austin and one near Texas City. Studies are still being made at the Texas City intersection.

At each intersection, a number of photometric measurements were made to serve as a check on calculated illumination values and also to provide information on illumination characteristics of such geometric features of the intersection as signs, curbs, and medians. These measurements also provided information necessary to give the scale model already described realistic visibility characteristics. Commercially available light meters and brightness meters were used to take the measurements. A specialized device available from the Illuminating Engineering Society has been utilized, and plans call for further instrumental evaluation of the Texas City intersection during 1961.

As in other detailed studies of traffic operation, numerous characteristics were measured. In general, these were reflections of the

performance capabilities of the vehicle and the manner in which it was operated by the driver. Those driver characteristics having the most effect on the operation of the vehicle were determined where possible. The interaction among vehicles in the traffic stream also significantly affected operational characteristics.

Measurement systems were developed for obtaining appropriate information on the following characteristics:

1. Traffic volume and composition.
2. Path and lane use.
3. Record of position with respect to other traffic.
4. Record of speed through the study area.
5. Stop sign observance and gap acceptance.
6. Merging traffic performance.
7. Familiarity of driver with the intersection.

Since little information was available on the techniques of studying operational characteristics of traffic at night, much effort has been devoted to experimenting and evaluating relatively untried techniques. Many of these approaches were based on the use of motion picture photography, used quite successfully in other operational studies by the Texas Transportation Institute. It was found that the motion picture method, as supplemented by manual observers and automatic recorders, was effective in measuring vehicular operation through the intersection. In one study, reference markers were placed on the intersection's curbs, medians, or center lines, in positions where the driver's attention would not be distracted from his driving task. In other studies, pneumatic road tubes were used to actuate lights mounted on a panel in the field of view of the camera, or to record on a standard twenty-channel operations recorder.

A camera vantage point was located on the Texas Transportation Institute's 60-foot portable aluminum tower, near enough to the intersections to allow for good photography, at the same time far enough removed to avoid distracting drivers. Day and night views from the tower at the Austin intersection are shown in Figure 2.

Satisfactory materials and techniques for night filming had to be developed. Vehicle headlights and tail lights were found to be clearly distinguishable on high-speed film. Further, when roadway

illumination was provided, the pavement and the reference markers could be photographed, but not clearly enough to record data with the desired precision. Even infrared lights with high-speed infrared film did not prove to be a satisfactory method of overcoming this difficulty.

It was found that the most satisfactory photographic method does not always provide data of the accuracy desired, since a great deal depends on such matters as the position of the lights, the height of vehicle headlights, the camera angle, the distance from the camera to the vehicle, and ultimately the proficiency and judgment of the technicians who record the data from the film.

Most of the film used in the study was recorded in black and white. However, when a few rolls of color film were used for experimental purposes, the reflector marker boards showed up more clearly. Recent studies have also been made with high-speed conventional film. A camera speed of 10 frames per second was used in all studies.

Concealed radar speed meters equipped with recording units were located some distance from the approaches to the intersection as a supplemental source of speed information.

In order to estimate the effect of familiarity, traffic from an area bounded by the three counties surrounding the test sites was considered as "local" traffic which could be assumed to be "repeat" traffic through the intersection. All other traffic was classified as "foreign" traffic.

The Austin intersection is complex, with many points of conflict within a limited area. The intersection was scheduled for illumination to an average level of 0.8 foot-candle, and a "before" and "after" study was conducted. The most intensive field studies were at the Texas City intersection, selected as a study area because of its complexity and its rural location. A rural area, with fewer conflicting light sources, offers more flexibility for research in illumination than does an urban area.

The illumination conditions studied at the Austin intersection included daylight, night with no illumination, spot (or critical point) illumination, and full continuous illumination. The studies at Texas City, not yet completed, provide for daylight and night studies with no illumination and spot lighting and full continuous

lighting with luminaires mounted 30 feet above the pavement. In addition, a minimum 30-foot spot lighting plan has been studied. Also, minimum and intermediate level illumination studies with luminaires at 45-foot mounting heights are under way.

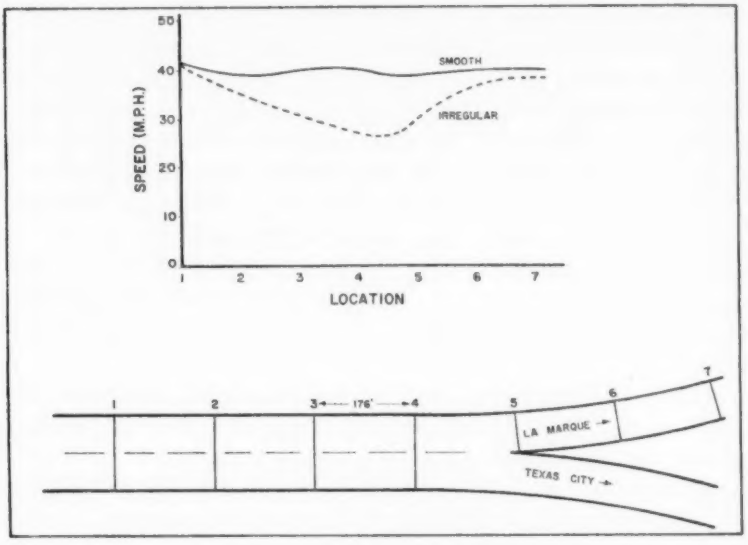

Figure 3. Speed Profile

A comparison of typical "speed profiles" of vehicles traveling through the intersection is shown in Figure 3. The variations in speed are a measure of the driver's reactions to his evaluation of the driving environment. A "smooth" profile is considered more desirable than an "irregular" profile. An incomplete analysis of the profiles for minimum levels of lighting is shown in Table I. There are no significant reductions in the number of "irregular" profiles with the addition of minimum levels of roadway illumination.

TABLE I—SPEED PROFILES BY LUMINAIRE CONDITION

Speed profile	*Luminaires Mounted at*		
	Off	30′	45′
Smooth	85%	82%	87%
Irregular	15%	18%	13%
Sample size	34	22	55

Studies of accidents at these test intersections are being made, but the total is so low that significant and meaningful results are not expected.

Other intersections were utilized for visual evaluation of special illumination. In one instance, lighting fixtures were attached to signs, and the behavior of night traffic under these conditions was observed. Also, the effect of illuminating the roadway from low-mount fixtures was observed.

DRIVER BEHAVIOR

There has been relatively little research on driver tension related to the level of illumination. In seeking a measure of the state of driver tension afforded by illumination, it was believed that the level of tension resulting from the complex decisions required at intersections after dark might be measurable. In psychology there are a number of measures of behavior that can be used to determine tension response. A tool measuring tension and relating it to the driving environment could be of great value. The galvanic skin reflex is the physiological measure most nearly fulfilling these requirements.

The galvanic skin reflex (GSR), or change in electrical skin resistance, has been much studied since 1888. Feré had discovered then that a galvanometer, fed by a weak current and connected in series with a subject with electrodes attached to the forearms, deflected quickly when the subject was stimulated by the sight of colored glass, the sound of a struck tuning fork, or by an odor. The response can be initiated by unexpected stimuli that may be startling or tension inducing. The GSR appears as a decrease in resistance with a magnitude proportional to the intensity of the inducing stimuli. A GSR occurs when conation or the act of striving is experienced; it is a sensitive indicator of mental functions and is associated with the subject's conscious experiences. It is particularly sensitive to sensory and ideational stimuli, especially those associated with alertness, attention, apprehension, and arousal. The GSR is perhaps a more sensitive index of higher-level mental functions than any other indicator of bodily change.

The findings of the study indicate that the GSR can be used by carefully trained personnel to produce consistent results. The GSR does discriminate between conditions of illumination, producing

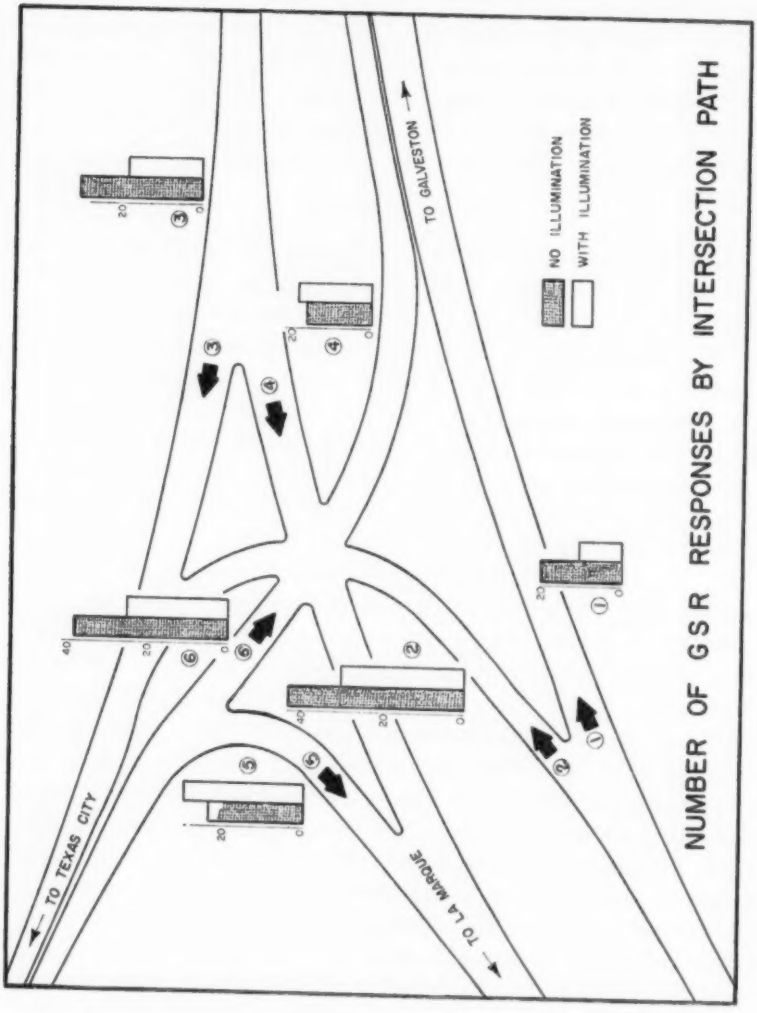
NUMBER OF G S R RESPONSES BY INTERSECTION PATH
NO ILLUMINATION
WITH ILLUMINATION
TO GALVESTON
TO LA MARQUE
TO TEXAS CITY
40
20
0

Figure 4

only 80 percent as many tension responses even under minimum illumination conditions as when there is no light at the test intersection. This effect is consistent for the young drivers tested. The more difficult and complex paths through the intersection generate more tension responses.

Figure 4 presents the number of tension responses recorded on the various paths through the intersection with the lights on and off. The addition of illumination provides no tension-response relief for movements 4 and 5. The location of the luminaires is such that movement 5 receives little additional light, and the high-speed diverging movement, number 4, is believed by a number of those who observed it in operation to be inadequately illuminated. Substantial reductions in tension responses are noted on those movements believed best served by the minimum-level illumination provided.

SIGN ILLUMINATION

Adequate signing is necessary to give the driver assistance in taking full advantage of our ever-improving highway system. Signs must be located to attract the driver's attention, to give him an adequate opportunity to read them, to command his obedience, and to provide time for proper response and action. The problem of sign location, recognition, and readability at intersections at night is of particular importance.

None of the numerous studies of the night target value and legibility of highway signs have made a quantitative consideration of changes in the legibility of signs as caused by the presence and location of standard roadway lighting or special lights designed to illuminate the signs. It is generally agreed that placing signs so that roadway luminaires illuminate them increases their legibility, but there is no information that such improvement is great enough to warrant its consideration in roadway illumination and sign location. The present studies have the objective of determining the effect and evaluating the applicability of findings relative to external illumination of roadway signs.

Two fluorescent lighting units suitable for the illumination of large overhead signs are being evaluated. Laboratory evaluation consists of placing the units at various spacings, and at various

angles, and measuring foot-candles of illumination over the face of the sign. The performance of these units was compared with the recommendations of the Institute of Traffic Engineers and the Illuminating Engineering Society. A table was prepared giving recommended fixture placement and spacing, and lamp and ballast combinations, for a sign of given dimensions in different illumination environments.

Because some large overhead interstate signs are not adequately illuminated from the bottom, a sun-shadow study is being made as part of the evaluation of top mounting.

Alternative signing as related to roadway illumination is being evaluated at the Texas City illumination test intersection. Three approaches, typifying older local practice, current good practice, and concepts acceptable to the 1961 *Manual of Uniform Traffic Control Devices*, are being tested under the varied illumination conditions described earlier in this article. A study of this type was recently completed in Dallas. Roadside signing was replaced with an overhead sign at an urban diverging movement and, later, special fluorescent sign lighting was attached to the sign. A similar study at a freeway intersection is planned for late 1961.

A comprehensive controlled study of the legibility distance of both roadside and overhead signs for various conditions of illumination is nearing completion at a specially constructed test area on the Texas A. & M. campus. Roadside signs reflectorized with paint and bead, reflective sheeting, and with corner-cube reflectorized letters on an unreflectorized background have been tested. Overhead signs with two types of reflecting letters used on exposed lens sheeting and coated sheeting provided by one manufacturer have been tested. A porcelain enamel unreflectorized background with corner-cube reflecting letters has also been tested. An interstate standard internally illuminated sign and a paint and bead sign are currently being evaluated.

The studies of roadside signs have included the effects of one and two luminaires, the longitudinal and lateral positioning of the sign, dynamic and static legibility, observer differences, two-headlamp and four-headlamp automobile lighting systems, and the effects of opposing vehicle headlights. Figures 5 and 6 present the results of studies on paint and bead roadside signs for slow speed

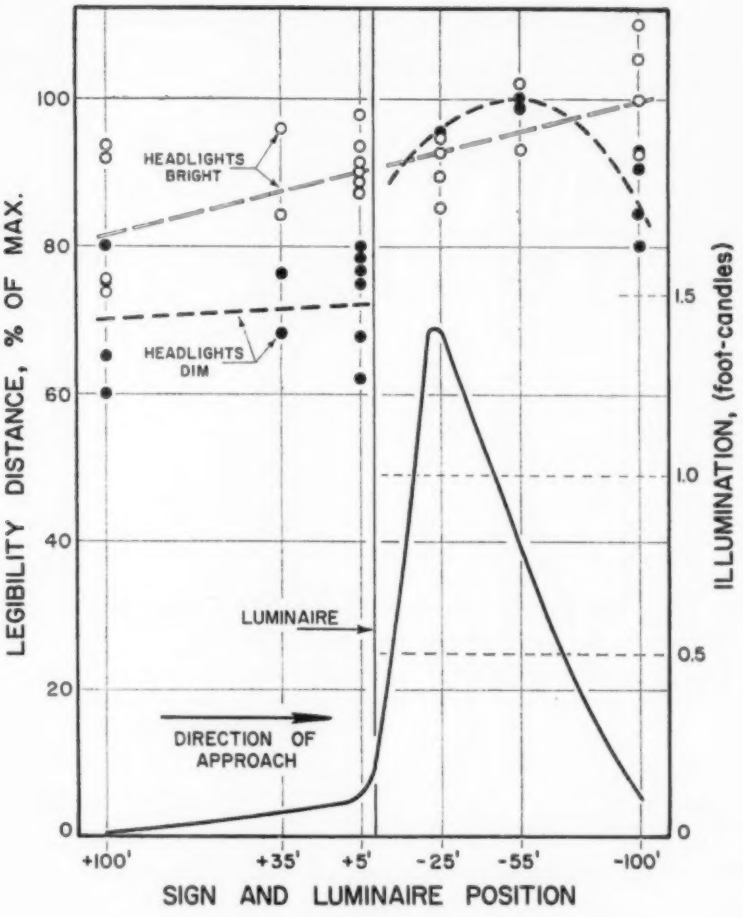

Figure 5. Roadside Sign Legibility and Illumination Intensity vs. Luminaire Location

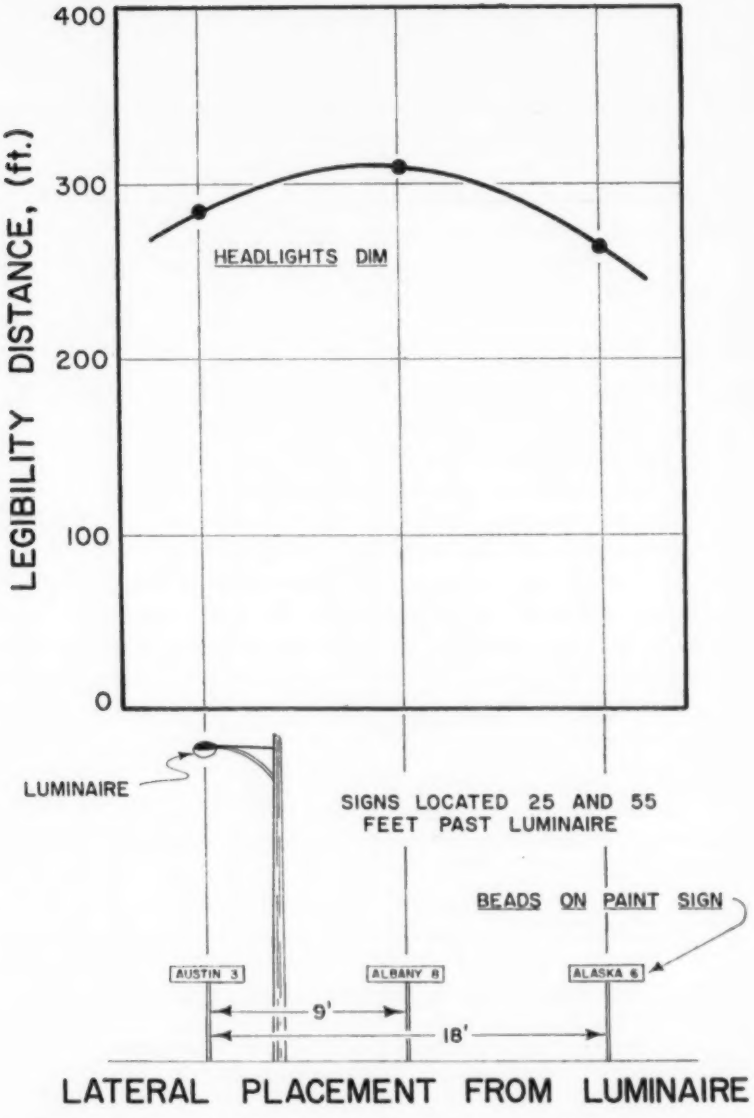

Figure 6. Roadside Sign Lateral Placement vs. Legibility Distance

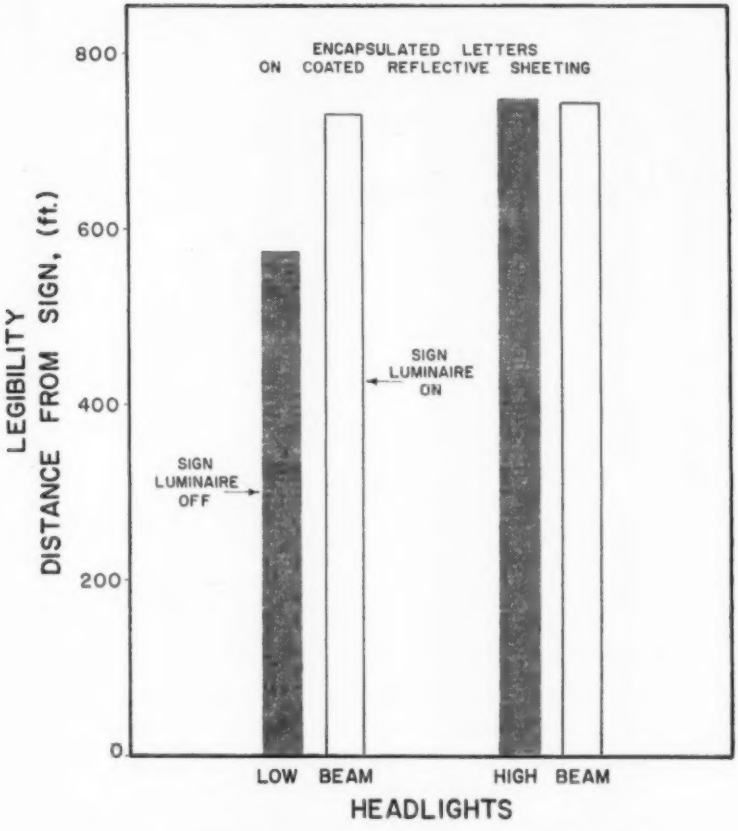

Figure 7. Effect of Fluorescent Sign Light and Headlight Setting on Overhead Sign Legibility Distance

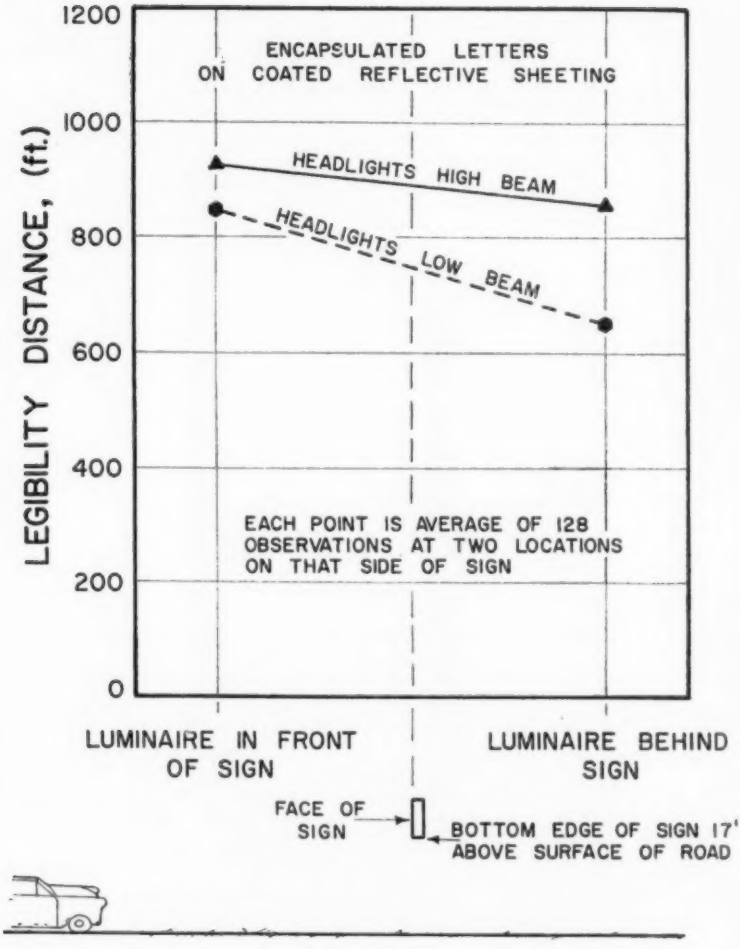

Figure 8. Overhead Sign Legibility vs. Luminaire Location

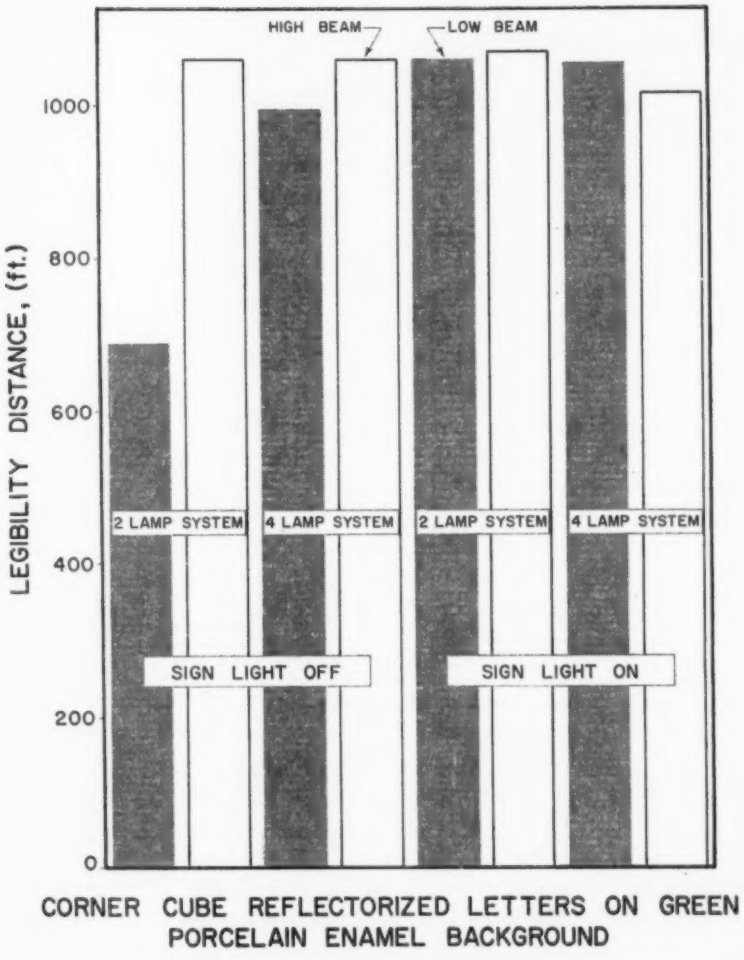

Figure 9. Overhead Sign Legibility Distance for Sign Light Condition, Headlight System, and Headlight Setting

legibility with two-headlamp lighting systems. Significant results have been found for the typical low-beam operating condition. When the sign is in front of the luminaire, it receives no direct light from the luminaire and is readable at only 70 percent of the distance at which it can be read when the sign is 55 feet behind the light. This improvement in legibility is greater than 100 feet, a significant value, equivalent to from one to two additional seconds of readability time at operating speeds, or nearly 2 inches extra of letter height. The study of the effect of lateral sign position for signs back of the luminaire indicates that a sign approximately 10 feet to the right of the luminaire can be read approximately 10 to 15 percent farther away than signs in the other positions shown in Figure 6.

The studies of overhead sign legibility have generally included the same factors as for the roadside signs, with the addition of the effects of the top and bottom mounting of the special sign-lighting units. The interstate standard 24-inch capital letters with their 18-inch lower case letters have also been compared with the smaller interstate standard letter for varying conditions of illumination. Figure 7 shows that for one overhead sign material using 16-inch capital letters and 12-inch lower case letters, the sign-lighting unit produces an increase in legibility distance equivalent to switching from low to high beams with a two-headlamp system, but for those vehicles operating with high beams it does little further to increase legibility distance.

The legibility effects of various locations of roadway illumination for a button reflectorized letter on a porcelain enamel Interstate green unreflectorized background are shown in Figure 8. For those vehicles operating with high beams the effects of luminaire placement are not significant, but those drivers operating with low beams derive a substantial improvement in legibility distance when the luminaires illuminate the sign face.

Figure 9 shows the legibility distances recorded for various combinations of headlight settings, motor vehicle lamp systems, and sign illumination for 16-inch capital letters and 12-inch lower case letters. The most significant difference is between the low-beam legibility given by the older headlamp systems and the recently introduced four-lamp systems.